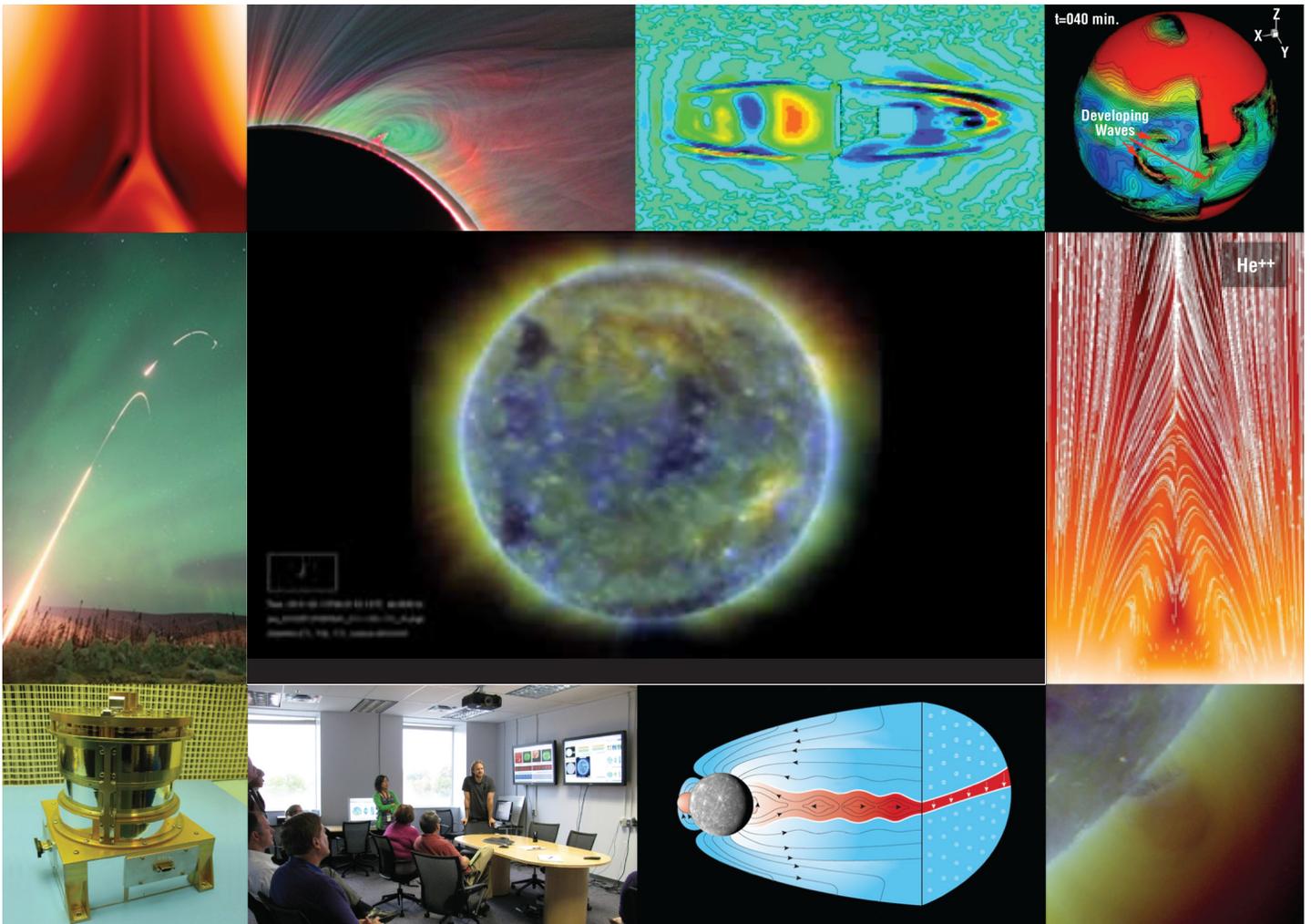




GSFC Heliophysics Science Division FY2010 Annual Report

*Holly R. Gilbert, Keith T. Strong, Julia L.R. Saba, Robert L. Kilgore, Judith B. Clark,
and Yvonne M. Strong, Editors*



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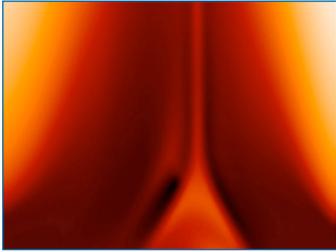
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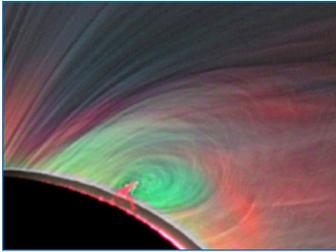
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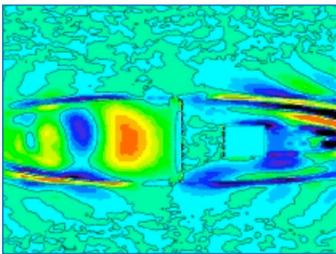
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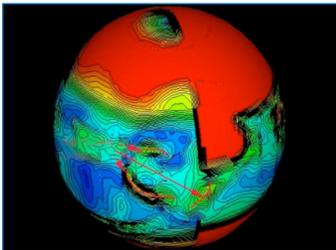
A model of the evolution of the electron distribution function in the solar corona and the solar wind, using a modified version of the existing Fokker-Planck code (see page A3).



A temperature map of the solar coronan derived from the Fe XI/Fe XI (red – cool) and Fe XIII/Fe XIV (green – hot) ratios taken during 2008 August 1 total solar eclipse (see page A25).



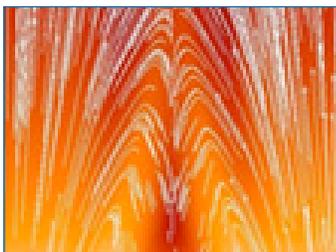
Excitation of strong electromagnetic perturbations in the solar wind by Solar Probe Plus in the inner heliosphere, with $E_0 = (0.3- 1.2)$ V/m. The jumps in the polarization electric field are 18–70 V/m in the plasma wake wing behind the bus (see page A69).



Simulated EIT wave as velocity enhancements of the plasma velocity parallel to the solar surface. The wave shows up at the fringe of an elliptical area, which includes an active region as the launching site of a CME triggering the EIT wave (see page A101).

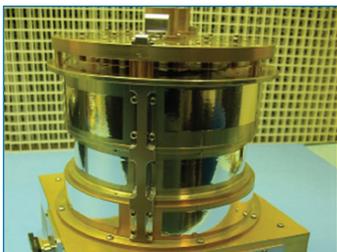


De-spun Rocket Borne Imagers flown on Rocket Observations of Pulsating Aurora four-stage sounding rocket launched 2007 February 12 (See page A50)



Results of three-fluid numerical model of a coronal streamer showing the flow pattern and density of He⁺⁺ ions in region 1 to 8 solar radii(see page A83).

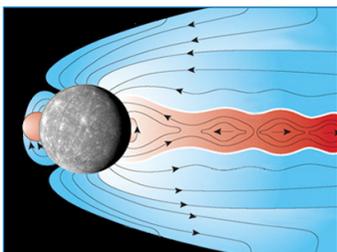
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The FASTSAT Miniature Imager for Neutral Ionospheric atoms and Magnetospheric Electrons (MINI ME), is a novel imager to detect low-energy neutral atoms formed in the plasma population of the Earth's outer atmosphere to improve global space weather prediction (see page D3).



HSD E/PO team is given a tour of the Community Coordinated Modeling Center (CCMC) by scientists in the Space Weather Laboratory. The CCMC is a multi-agency partnership to enable, support and perform the research and development for next-generation space science and space weather models (see pages 27 for EPO and 37 for the CCMC).



The extent of Mercury's magnetosphere for $B_z < 0$ in the interplanetary magnetic field.

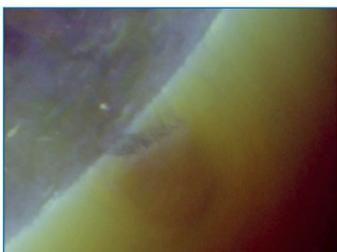
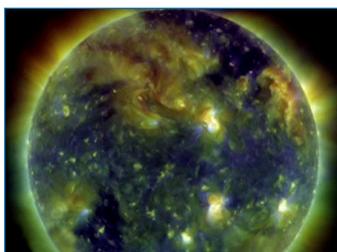


Image of a prominence and cavity from SDO/AIA 2010 July 11 incorporating data from the 211-, 193-, and 171-Å bands used in modeling their 3D structure (see page A63).



A seven-month movie from the Solar Dynamics Observatory (SDO) showing the evolution of the solar corona since SDO's launch in February 2010 (see pages 15 and C3).

Foreword

This report presents the scientific, technological, educational, and flight project achievements of the Goddard Space Flight Center (GSFC) Heliophysics Science Division (HSD) for FY2010. HSD consists of scientists, technologists, engineers, education and public outreach (E/PO) specialists, and administrative personnel dedicated to advancing our knowledge and understanding of the Sun and the wide variety of domains influenced by its variability.

HSD's mission is to explore the Sun's interior and atmosphere, discover the origins of its temporal variability, understand its influence over the Earth and the other planets, and determine the nature of the interaction between the heliosphere and the local interstellar medium.

We achieve these strategic goals by:

- Leading science investigations involving flight hardware, theory, modeling, and data analysis that will answer the strategic questions posed in the Heliophysics Roadmap
- Leading the development of new solar and space physics mission concepts and supporting their implementation as Project Scientists
- Providing access to measurements from the Heliophysics Great Observatory (HGO) through our Science Information Systems
- Communicating science results to the public and inspiring the next generation of scientists and explorers

The outcomes we seek are to:

- Open the frontier to space environment prediction
- Understand the nature of our home in space
- Safeguard the journey of exploration

One obstacle to achieving a more efficient HSD organization with strong interdisciplinary communication was the fact that our personnel were located in 6 buildings spread across the GSFC campus. With the support of Center Management, especially Facilities, who were responsible for extensive building modifications (see the Facilities section on pages 11 – 13), we embarked last year on an ambitious program to consolidate all HSD personnel into Building 21. By the end of FY2010, over 80% of us were resident in Building 21 with the rest scheduled to move in by the end of the first quarter of FY2011. Our special congratulations and thanks go to our Assistant Director, Mike Horn, who took on this immense logistical challenge, with essentially every person, office, and laboratory being moved one or more times, and made it all work with minimal impact to our important scientific activities and flight programs.

The main tools that HSD uses to accomplish its scientific goals are a network of advanced instrumentation carried on a variety of space platforms. These missions make up the Heliphysics Great Observatory and HSD plays a key role in all of the heliophysics missions both currently operating missions and those in development.

Heliophysics is one of the four disciplines that form the backbone for NASA's Strategic Plan for Earth and Space Science.

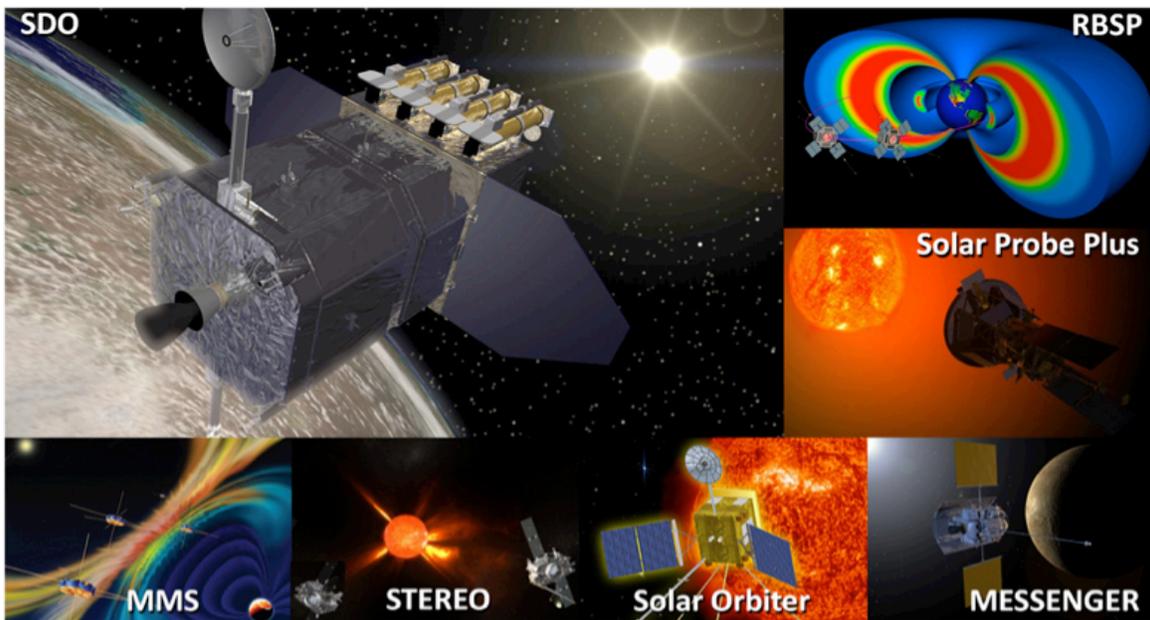
GSFC has critical enabling roles in all heliophysics science projects, including mission formulation and development, instrumentation, data systems, science theory, analysis, and modeling, and education and outreach

This past year we successfully consolidated all HSD personnel and functions into a newly renovated Building 21. This new facility will enable an integrated, team approach to our mission.

FY10 was outstanding with the successful launch and checkout of the Solar Dynamics Observatory (SDO) and the announcement that HSD has been selected to provide energetic particles instrumentation for the Solar Probe Plus (SPP) mission.

Each of the operational elements of the Heliphysics network provides a unique aspect of the space weather puzzle. For example, the STEREO mission is providing unique multi-aspect observations of the solar corona and coronal mass ejections which for the first time is making possible the 3D reconstruction of the dynamics of the optically thin magnetic structures which drive solar variability. The Solar Dynamics Observatory (SDO) has recently joined the solar oriented missions providing near continuous solar helioseismological and coronal observations while monitoring with high precision the EUV emissions that are most effect the Earth's atmospheric chemistry, dynamics, and scale height. MESSENGER provides a close-in measurement of solar energetic particles and the interplanetary magnetic field while determining how and why Mercury's magnetosphere is so dynamic relative to the Earth and the outer planets.. For more details on these and other operational missions see Appendix C.

HSD is looking forward to a series of new missions to be launched over the next few years that will extend vital observations as well as fill in gaps in our current capabilities. Radiation Belt Storm Probes (RBSP) will venture into the Earth's radiation belts to help us understand why these regions of highly charged plasma change so much. Magnetospheric Multiscale (MMS) will look at the



Some of the current and future elements of the heliophysics great observatory

important microphysics of magnetic reconnection in the magnetosphere but this has relevance to solar and astrophysical processes. Meanwhile Solar Orbiter will co-rotate over solar active regions as they develop and flare. Solar Probe will venture into areas close the Sun that have not yet been explored by any other spacecraft. Details of these and other developmental missions are in Appendix D.

HSD is composed of 323 scientists, engineers, and other staff supported by a small management and administrative team. HSD comprises 72 (22%) civil servants, 32 (10%) co-located civil servants from the technical divisions, 121 (37%) contractors, 17 (5%) emeritus, 14 (4%) NASA Postdoctoral Fellows, and 70 (22%) university scientists working under cooperative agreements (see HSD Organization section for more details, page 7).

HSD also welcomed 13 new civil service scientists in FY2010: Drs. Joel Allred, Fred Herrero, Alex Glocer, Sarah Jones, Shri Kanekal, Emil Kepko, Georgia de Nolfo, William Paterson, Craig Pollock, Lutz Rastetter, Albert Shih, Lynn Wilson, and Yihua Zheng.

Individual scientists and teams from HSD garnered important professional honors in FY2010:

- Michael Hesse was elected as an AGU fellow
- Thomas Moore received NASA's Exceptional Service Medal
- David Sibeck received NASA's Exceptional Science Achievement Medal

HSD Principal Investigators won 6 new ROSES 2009 grants as well as numerous Co-Investigator awards. The new HSD PIs are: Gordon Holman, Aaron Roberts, Holly Gilbert, Jim Klimchuk, and Pete Schuck (two PI selections!).

Eric Christian is the Deputy PI for the Integrated *Solar Probe* Imaging Suite (Lead: David McComas/Southwest Research Institute), which was selected for the Solar Probe Plus mission. Eric will also be providing critical hardware elements of the Energetic Particles Instrument–HI and co-leading this instrument investigation. GSFC Co-Is on other selected Solar Probe Plus investigations include, in addition to Eric, the GSFC Mission Scientist, Adam Szabo, Jim Klimchuk, Mel Goldstein, Bob MacDowall (695), and Bill Farrell (695).

HSD Mission milestones includes the successful launch of the Solar Dynamics Observatory on 2010 February 11 from the Cape Canaveral Air Force Station Complex 41 on an Atlas V401 (see SDO mission; page C3). SDO is already providing new and exciting scientific data that have caught the imagination of the science community and the public (see SDO science highlight; page 15). Our special congratulations to Dean Pesnell (671) who has served as SDO Project Scientist throughout its development and, now, operational phase.

Other operational Heliophysics Great Observatory missions have continued gathering data at the critical transition between an extraordinarily extended and quiet solar minimum into the rise of solar cycle 24 (see Appendix C). This is an important time especially for space weather studies because of the relatively simple structure of the solar magnetic field and heliosphere due to the lack of complex dynamic structures. Thus, the effects of new activity can be followed from its origins on the Sun all the way to geospace and enables more straightforward tests for our models and theory capabilities.

This year HSD scientists completed and delivered three new flight instruments for the FASTSAT mission led by Marshall Space Flight Center. This effort is led by John Sigwarth and includes his own Thermospheric Temperature Instrument, as well as Doug Rowland's instrument the Plasma Impedance Spectrum Analyzer and Michael Collier (695) leading the Miniature Imager for Neutral Ionospheric atoms and Magnetospheric Electrons. All these instruments contain new technologies; their mission is technology validation as well as the gathering of new Geospace science measurements.

HSD scientists published 201 papers in refereed scientific journals in FY2010 of which 44% had one of our scientists as first author. HSD has 57 papers in-press or submitted. We also gave 406 presentations at 75 different conferences (see Appendix B for details).

HSD scientists authored several significant papers published this year:

- "Width and Variation of the ENA Flux Ribbon Observed by the Interstellar Boundary Explorer", *Science*, 326(5955), 962-964 by Fuselier et al. 2009
- "Global Observations of the Interstellar Interaction from the Interstellar Boundary Explorer (IBEX)", *Science*, 326(5955), 959-962 by McComas et al. 2009
- "MESSENGER Observations of Extreme Loading and Unloading of Mercury's Magnetic Tail, *Science*," 329(5992), 665-668 by Slavin et al. 2010
- "Geodynamo, Solar Wind, and Magnetopause 3.4 to 3.45 Billion Years Ago," *Science*, 327(5970), 1238-1240, by Tarduno et al. 2010

There were some particularly interesting and important scientific advancements resulting from the work of HSD scientists in FY2010:

- **SDO Launched:** The first of NASA's Living With a Star missions is now on orbit and producing spectacular high-resolution data in unprecedented quantities (page 15).
- **Solar Activity On the Rise:** Just as solar cycle 24 starts to rise, the two STEREO spacecraft will both be separated by over 90° from the Earth and so give us the first 360-degree images of the Sun when used in conjunction with the SOHO and SDO instruments (page 16).
- **Advances in Coronal Jet Modeling:** It was recently discovered that coronal jets are a much more common phenomenon than was previously believed (Hinode) and that they can exhibit twisting motions (STEREO). Models developed in HSD can now reproduce both the jet speed and helical structure (page 17)
- **Coronal Collisions:** RHESSI observed for the first time two plasmoids that apparently merged. Coordinated radio observation confirm that particle acceleration was occurring and that this coincided with the acceleration phase of a CME (page 18).
- **Understanding Solar-Wind Turbulence:** The highly dynamic solar wind is hotter than expected, and the origins of this heating remain unresolved. Recent results from Cluster have given us new information on how the protons in the solar wind are heated. A close encounter of the 4 Cluster spacecraft provided an ideal opportunity to observe for the first time the dissipation of the turbulence at a small scale (page 19).
- **Ripples in the Solar Wind:** Large-FOV coronagraphs have seen ripples in the solar wind, which have been thought to originate from CMEs, but STEREO data has been used to derive the trajectory and, when combined with in situ measurements, shows that the ripples are due to slow-moving plasma being swept up by the fast solar wind (page 20).
- **CMEs and Interplanetary Shocks:** Using a combination of SOHO, Wind, and ACE data, the driver of all interplanetary shocks was found to be associated with a CME (page 21).
- **Mercury's Dynamic Magnetosphere:** MESSENGER discovered that Mercury's magnetosphere is particularly responsive to changes in the interplanetary magnetic field despite Mercury's stable magnetic field (page 22).
- **Variability of the Outer Boundary of the Solar System:** IBEX last year announced the discovery of a bright ribbon of ENA at the outermost edge of our solar system where the heliosphere interacts with the interstellar medium. A second map now shows that, although the large-scale structure is stable, there is variability in some of the smaller scale features (page 23).

Further news and developments regarding our organization and facilities, instruments, missions, and science highlights can be found on our Website (<http://hsd.gsfc.nasa.gov/>). We thank you for your interest in our programs, and welcome feedback via the website.



James A. Slavin, Director
NASA GSFC Heliophysics
Science Division
December 2010

Preface

This document summarizes the work performed in FY2010 by members of HSD (Code 670) who conducted research, developed models, designed and built instruments, managed projects, and carried out many other activities that have made significant contributions to our understanding of the Sun's domain. Unfortunately, only a small fraction of these activities can be even briefly highlighted in this report.

The main body of the report describes the scientific studies that heliophysics encompasses and the components of the HSD program at GSFC that help the heliophysics community achieve its goals, including educational and public outreach activities. The HSD program involves research by its scientists, and their active research is summarized in Appendix A. Appendix B is a bibliography of the publications and presentations made by members of HSD in FY2010. Appendixes C and D give a brief description of the current heliophysics missions and missions in the development phase, respectively. Many acronyms are used in the report, which are in common usage and so are not independently defined in each section; a full list of acronym definitions is given in Appendix E. Another new feature of the FY2010 report is the inclusion of videos and animations.

The production of this report was led by Holly Gilbert, HSD Associate Director for Science. Keith Strong and Julia Saba (SP Systems) assembled the contributions, checked the report for accuracy, made suggestions regarding its content, and contributed to several sections. Julia Saba and Yvonne Strong (American Society for Microbiology) helped with the scientific and technical editing, and Keith Feggans (Sigma Space Corp) contributed by compiling the large HSD bibliography. Jay Friedlander (QSS Inc.) took photos of the new facilities in B21. Graphics support was provided by Robert Kilgore (TRAX International and TIMS). The final document was edited, assembled, and formatted by Judith Clark (TRAX International and TIMS), who helped with technical advice and suggestions throughout the process of producing this report. Many others in HSD helped with useful and constructive suggestions concerning the organization of this report and its content, as well as writing, refereeing, or updating sections.

We hope that the report is interesting as well as informative. Suggestions for additional information or improvements are encouraged.

Holly Gilbert, Keith Strong, and Julia Saba
December 2010

Introduction

Heliophysics is the study of the domain of the Sun—the heliosphere—from the nuclear core in the center of the Sun where hydrogen is transmuted into helium, producing the energy that drives changes throughout the entire solar system, to the edge of interplanetary space where the solar wind and magnetic fields cede control of the local physical conditions to the interstellar medium. That represents over a volume of over 10^8 AU³ suffused with outflowing plasma, magnetic fields, and solar radiation, with temperatures ranging from near absolute zero to over 20 MK.

The heliosphere is an interconnected network of physical processes driven by a relentless but varying outflow of energy from the Sun in the form of electromagnetic radiation from γ -rays to radio emissions, charged and neutral particles, and magnetic fields. All these forms of solar emissions interact in different ways in the wide range of environments from the hot solar interior, through the Sun's thin surface layers, into the extended solar corona, and throughout interplanetary space to the very edge of the solar system. Along their tortuous path, these emissions interact with different planetary environments, comets, asteroids, and interstellar gas – each with its unique response to the changing solar stimuli. HSD's goal is to understand this system of systems.

Accomplishing this goal involves the study of the complex interactions between electromagnetic radiation, thermal plasmas, energetic particles, and magnetic fields, with three principal objectives:

- To understand the changing flow of energy and matter throughout the Sun, solar atmosphere, heliosphere, and planetary environments
- To explore the fundamental physical processes that characterize space plasmas
- To define both the origins and the societal impacts of variability in the Sun–Earth system

There are four major physical domains that encompass HSD's mission: the Sun, the inner heliosphere, geospace, and the outer heliosphere. In addition, each planet, moon, asteroid, and comet interacts with the solar output in a different way depending on its size, distance from the Sun, atmospheric composition, axial tilt, orbital eccentricity, and magnetic field. The Sun also interacts with the interstellar medium in a boundary layer called the heliopause.

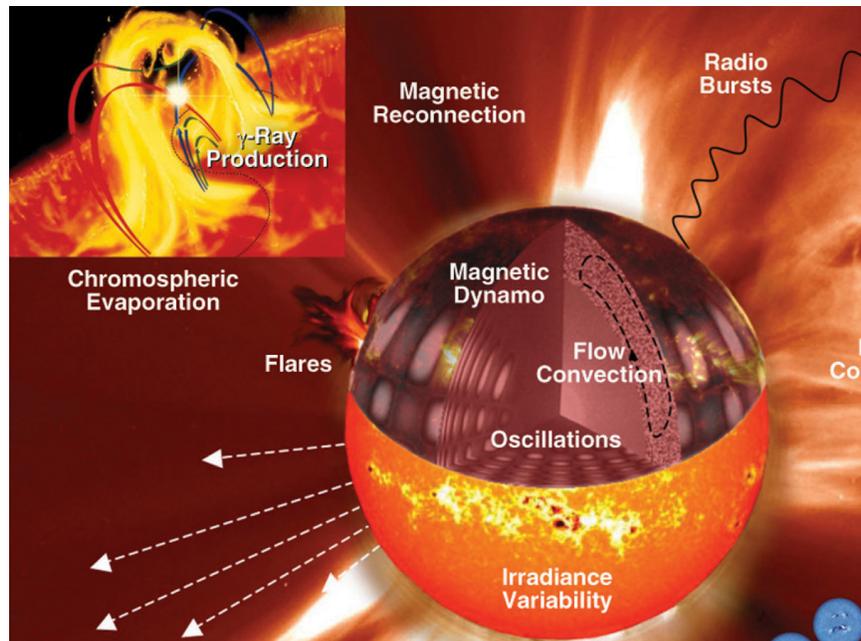
Heliophysics has practical applications as well. Solar variability leads to a dynamically variable near-Earth environment with impacts on technological systems both in space and on the ground, and corresponding effects on life and society. This is referred to as “space weather.”

Space weather has direct effects on satellite orbits, electronics, power systems, sensors, communications, GPS, power and energy industry, and commercial aviation. It is a concern in the realm of national defense and will be a major safety factor for deep-space exploration.

The Sun

The Sun not only generates radiant energy and accelerates particles, but also produces magnetic fields. The solar dynamo, driven by both radial and latitudinal differential rotation, generates magnetic fields and stores vast amounts of energy in them. Convection in the outer layers of the Sun and the natural buoyancy of the flux ropes drag these strong fields (>1000 G) to the surface, as evidenced by the presence of sunspots and faculae, which change the solar spectral irradiance that provides the energy to drive Earth's weather and climate system. Thus, a significant change in solar irradiance could affect Earth's climate.

Energy is transported from the solar core region (the inner 20% of the solar radius) by photon radiation out to about 70% of the solar radius. Then convective transport takes over, carrying most of the energy



Anatomy of the Sun

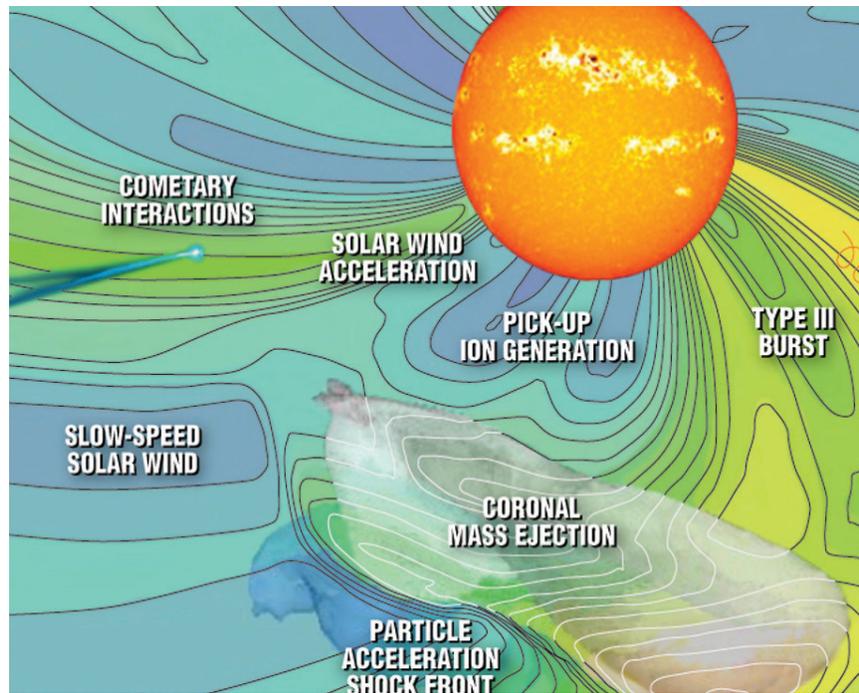
to the surface of the Sun—the photosphere—where the optical depth of the solar plasma drops, so that much of the energy can be radiated away into space. The falling temperature gradient as the energy flows outward seems well understood; however, just above the relatively cool surface layers, the temperature of the plasma rises rapidly again to form a 1-MK corona. The physical processes involved in creating and maintaining the corona are not completely understood as yet.

The energy stored in the solar magnetic fields is often released suddenly by rearrangements of the solar magnetic field, including magnetic reconnection, to produce flares and coronal mass ejections (CMEs). Flares produce emissions from γ -rays to radio wavelengths, accelerate solar energetic particles, and transport material from the lower layers of the atmosphere up into the hot corona via chromospheric evaporation, accompanied by ejection of material away from the Sun. CMEs are vast ejection events that can grow to be many times the size of the Sun and at times move with velocities exceeding 2000 km/s. Another type of mass outflow from the Sun is more continuous but also highly variable: the solar wind, which flows out along the spiraling solar magnetic field with velocities of between 300 and 700 km/s with various temperatures, densities, and compositions. The manner of its acceleration is still not well understood.

The Inner Heliosphere

This is the region between the Sun and Jupiter that is filled with outflowing, supersonic solar wind and frozen-in spiraling magnetic fields—the Parker Spiral. The streams of solar plasma evolve significantly as they pass through this region, where fast streams of solar wind plough into slower-moving ones, forming shocks. Transients, such as CMEs, reshape the ambient environment. Some CMEs move faster than the local solar wind, building up high-density fronts that form shocks where particles are accelerated to extremely high energies. CMEs can expand as they move outwards, leaving low-density regions behind the propagating front.

Electrons flow along the large-scale magnetic field lines, producing radio bursts of various types, and showing which field lines remain connected back to the Sun and which ones have reconnected. Because of the spiral nature of the fields, Earth is better connected to the west limb of the Sun; thus, an event at or near the west limb is more likely to be geoeffective than one in the eastern hemisphere



A CME propagates through the heliosphere towards Earth.

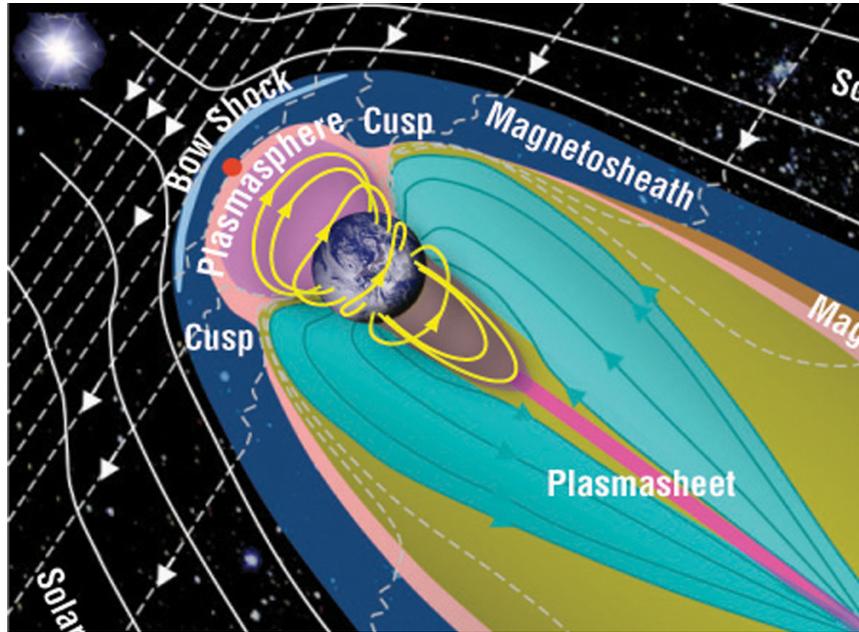
of the Sun. Photons take only 8 min to arrive at Earth from the Sun, and high-energy protons can be detected a few minutes later, whereas lower speed material from a CME event seen on the Sun may take up to 3 days to arrive.

Geospace

Earth's magnetic field acts as a barrier to most of the harmful particle fluxes originating from the Sun. Much of the solar wind is directed around the magnetosphere, which forms a teardrop-shaped shield around Earth. The shape and size of the magnetosphere change as solar wind conditions vary. Earth's magnetic field is compressed within about 10 R_E on the sunward side of the planet and is stretched out by many tens of Earth radii on the anti-sunward side. The faster and denser the winds, the more the fields are compressed and stretched. The direction of the interplanetary magnetic field profoundly influences the Sun-Earth interactions. A CME with a dominant southward magnetic field oppositely directed to the interplanetary field will more likely reconnect, allowing more energetic particles to enter geospace and producing strong geomagnetic storm.

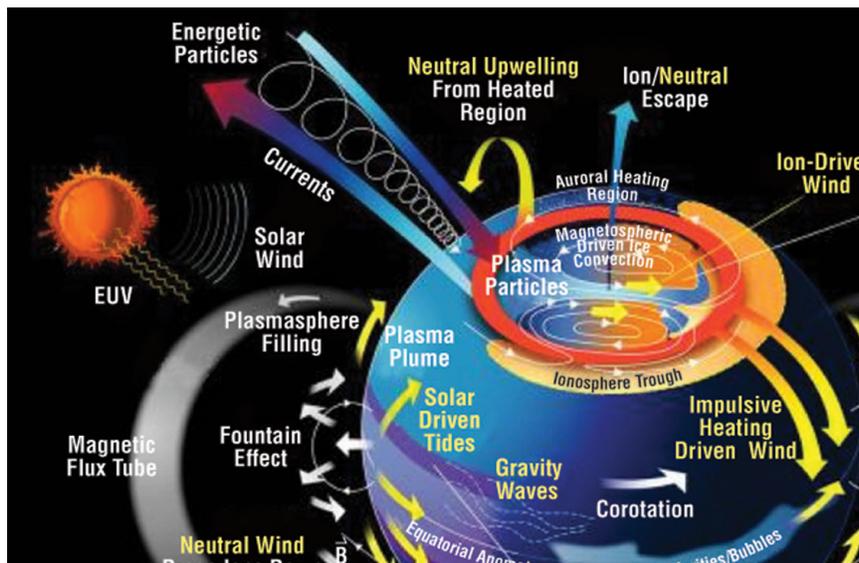
Where the solar wind and Earth's magnetic field collide there is a bow shock region. The fields become weak and disorganized as they interact in the magnetosheath, the region between the bow shock and the magnetopause, which contains turbulent magnetic fields. The magnetopause is the irregular and highly variable surface where the Earth's magnetic pressure is balanced by the solar wind. The magnetopause often ripples and flaps in the solar wind, and parts constantly magnetically reconnect and break away. Over the Earth's polar regions and the high-latitude "cusp" region, solar particles have access to the magnetosphere via open field lines that connect to the interplanetary field.

Closer to Earth, a completely different set of closely coupled processes dominate. Here, solar radiation plays a major role. UV light from the Sun, especially when enhanced by flare emissions, heats the neutral atmosphere, increasing its scale height and resulting in orbital drag experienced by spacecraft, reducing their orbital life.



The complex structure of the Earth's magnetosphere

Gravity waves propagate up from below in the neutral atmosphere. The thermosphere becomes partly ionized by absorbed solar emissions that heat it increasingly with altitude. As a result of changing inputs, it becomes highly dynamic. The ionosphere, the first completely ionized layer of Earth's atmosphere, becomes very disturbed at times of high solar activity; these disturbances, in turn, and interfere with many forms of HF radio communications, and cause bulk outflow of the ionosphere into the magnetosphere from the auroral zones. The Earth's radiation belts chiefly contain trapped populations of electrons and protons ranging in energy from a few hundred keV to tens of MeV. The radiation belts overlap spatially with the plasmasphere containing low-energy (few to tens of keV) plasma, which sustains many different kinds of plasma waves. Structurally the radiation belts comprise an outer and inner belt separated by a slot region bereft of electrons. The outer belt comprises largely of trapped electrons, which are the result of energization of a low energy seed population supplied by substorms. Plasma waves play a dominant role in energizing these electrons to high energies.



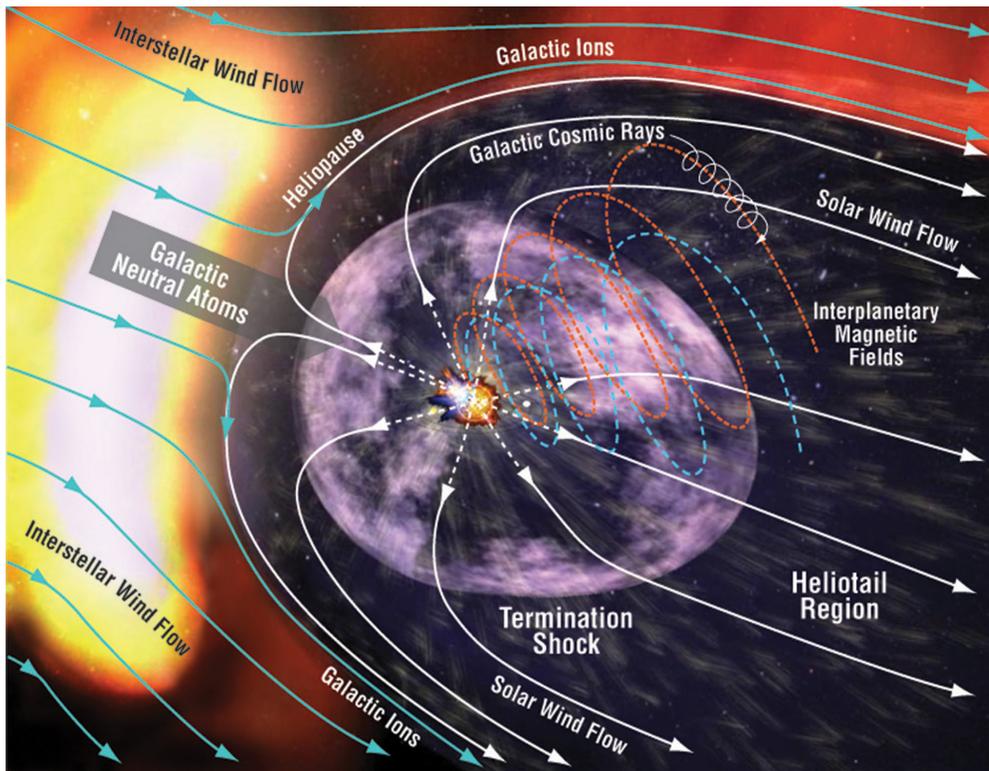
Some of the physical processes that occur when incoming radiation and charged particles interact with Earth's dynamic atmosphere

The inner belt comprises largely protons resulting from the decay of cosmic ray neutrons as well as solar protons that are trapped by the nearly dipolar inner geomagnetic field. The process of energization and trapping occur not only in the terrestrial magnetosphere but also in other magnetized planets and in astrophysical contexts. Apart from scientific aspects, there is the practical necessity to understand the dynamics of these high-energy particles as they may cause deleterious effects to spacecraft and humans in space.

The Outer Heliosphere

The characteristics of the heliosphere significantly change past the orbit of Jupiter—this area is called the outer heliosphere. Here, the solar wind and transients interact with the gas-giant planets, which are very different from their rocky cousins in the inner heliosphere.

In this region, the nature of the outflowing plasma also changes; the interplanetary magnetic field becomes mostly azimuthal and therefore is perpendicular to the solar wind flow; this is where solar transients and interplanetary shocks catch up with each other and form large Global Merged Interaction Regions. In addition, a larger portion of the solar wind is composed of photoionized interstellar neutral particles, known as pickup ions.



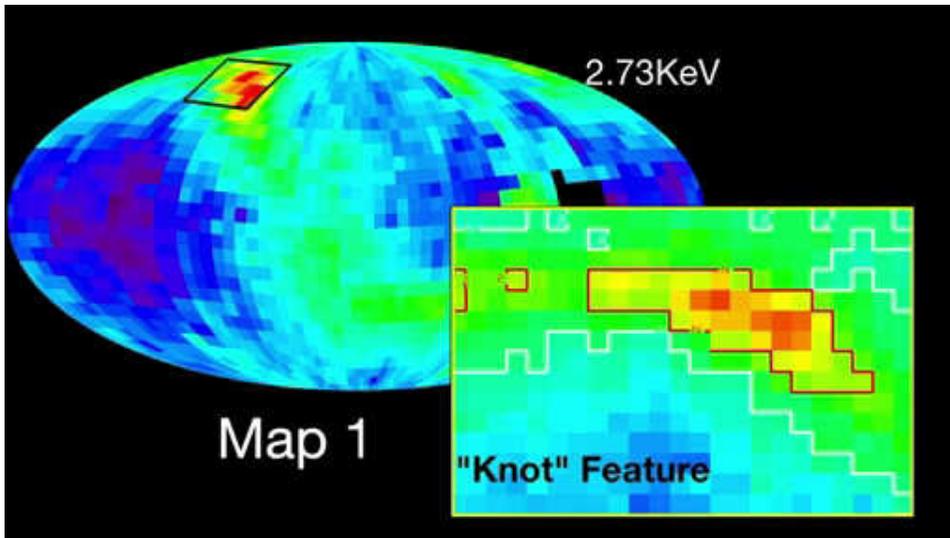
The interactions between the solar wind and the interstellar medium create a range of unique phenomena

With increasing distance from the Sun, the particle and field pressure of the solar wind decreases until it reaches pressure balance with the local interstellar medium. This boundary is called the heliopause; however, before reaching this boundary, the solar wind has to slow abruptly below its supersonic speed at the termination shock, and start deflecting toward the heliotail and continue slowing down in the region known as the heliosheath. The interaction of the heliosphere with the interstellar medium is analogous to the solar wind deflecting around Earth's magnetosphere. It is postulated that the

interstellar plasma could also flow at supersonic speeds, necessitating the existence of an external bow shock and a pileup of interstellar particles upstream of the heliosphere, known as the hydrogen wall.

Besides low-energy neutral particles, the extremely high-energy galactic cosmic rays also enter the heliosphere, but not without first being modulated by the periodically varying heliospheric magnetic fields. The termination shock and heliosheath are also thought to be the source of an anomalous component of the cosmic rays observed at Earth.

The new technique of ENA imaging has given us our first images of the outer heliosphere from the IBEX Mission, and we are finding that the boundary is variable in both its intensity and structure.

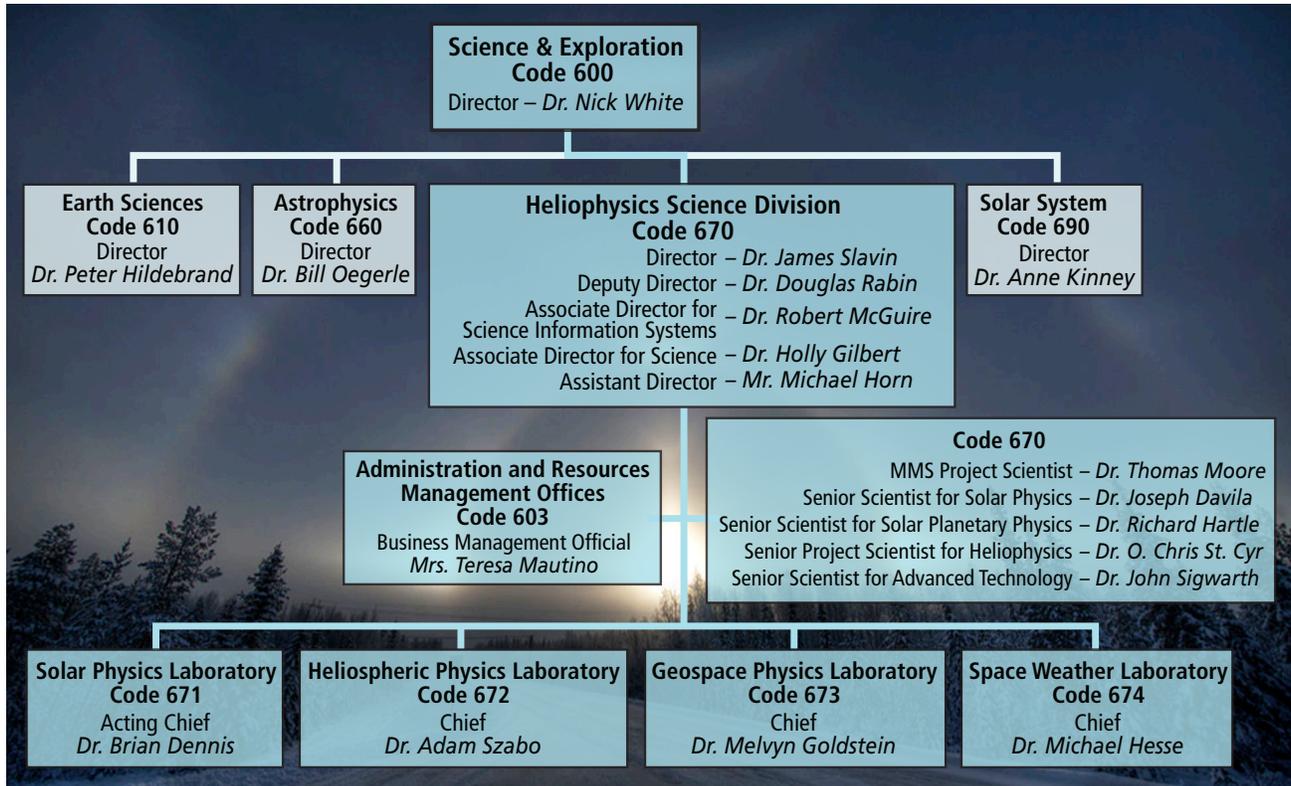


An ENA image of the outer heliosphere taken by the IBEX Hi channel (0.9 – 1.5 keV showing the current locations of Voyager 1 (V1) and Voyager 2 (V2).

The HSD Organization

At the end of FY2010, HSD was composed of 323 scientists, engineers, and other staff supported by a small management and administrative team. HSD comprises 72 (22%) civil servants, 32 (10%) co-located civil servants, 121 (37%) contractors, 17 (5%) emeritus, 11 (3%) NASA Postdoctoral Fellows, and 70 (22%) university scientists working under cooperative agreements.

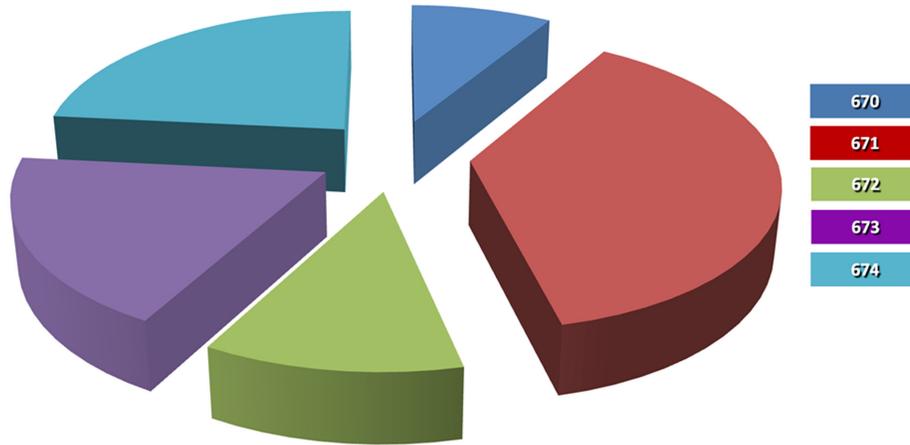
HSD is supported primarily by competitively awarded funding from the NASA Science Mission Directorate, with the remainder made up of assigned NASA tasks, GSFC research and development investments, and funding provided by other Federal agencies.



HSD is divided into four laboratories

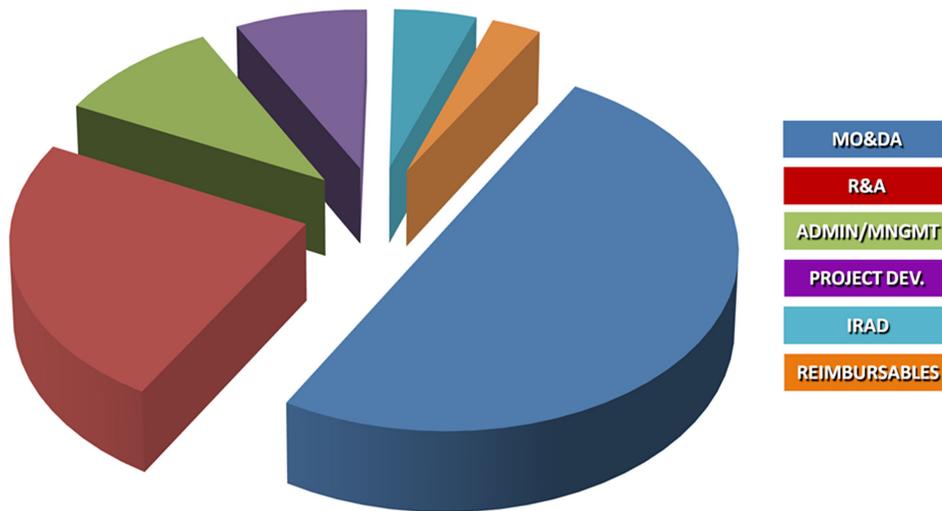
- Solar Physics (Code 671)
- Heliospheric Physics (Code 672)
- Geospace Physics (Code 673)
- Space Weather Physics (Code 674)

All of the laboratories are supported by a small administrative and management group (Code 670) in the proportions shown in the following chart:



HSD Laboratory Structure

This staffing level is supported by a variety of funding sources:



HSD Support in FY2010

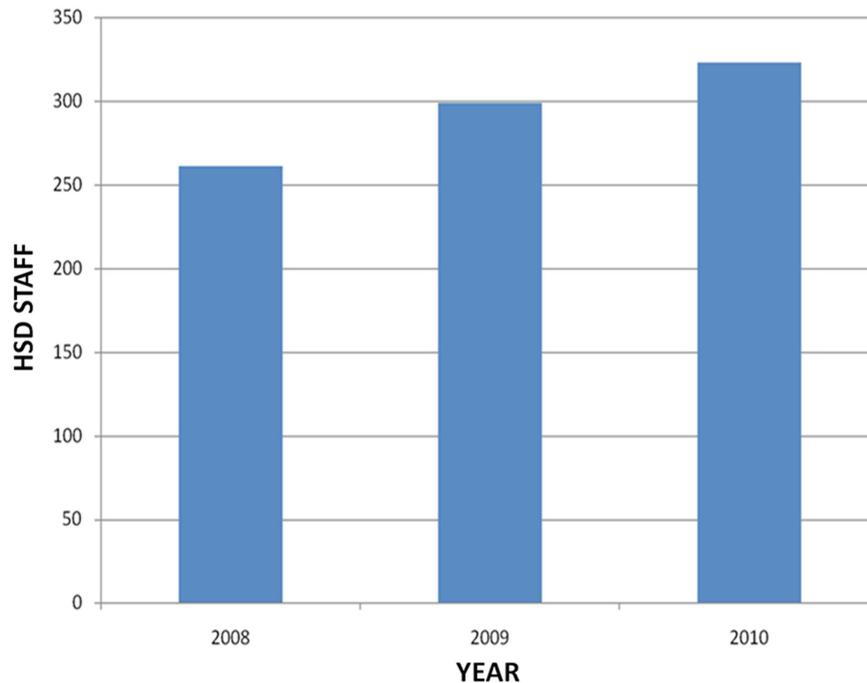
Missions Operations and Data Analysis (50%) and Research and Analysis (24%) provide the bulk of HSD support. IRAD (5%) supports the development of technologies for the next generation of heliophysics missions. Project Development (8%) and Reimbursables (3%) with the HSD administrative and management support (10%) makes up the remainder.

HSD responsibilities include:

- Scientific Research: HSD staff working as principal investigators (PIs), Co-investigators (Co-Is), instrument scientists, and flight team members have published 231 papers and given over 414 presentations at 75 different scientific meetings in FY2010 (see Appendixes A and B for details).
- Project and Mission Scientist Assignments: HSD provides the project and mission scientists who manage operating heliophysics missions, as well as missions in development (see the Missions sections, Appendixes C and D, for details).

- Future Mission and Instrument Concept Development: HSD provides scientific leadership and technical support for science mission concept development and formulation.
- Data and Modeling Centers: HSD scientists lead and operate four major centers that provide critical data services and simulation and modeling services to the heliophysics community. They are the Space Physics Data Facility, the Solar Data Analysis Center, the Heliophysics Data and Modeling Consortium, and the Community Coordinated Modeling Center. These centers are funded directly by NASA and reviewed periodically by NASA Headquarters-appointed external committees.
- Education and Public Outreach (E/PO): HSD specialists and scientists, led by the Associate Director for Science, carry out a variety of E/PO tasks supported by project and competitively awarded funding.

Like many government, academic, and industrial research laboratories that perform basic and applied research in specialized areas, HSD has experienced recruitment challenges in replacing retirees and recruiting new staff to attain its research goals while achieving greater ethnic and gender diversity in the HSD workforce. For this reason, HSD is actively recruiting within the university community to attract new postdoctoral, cooperative agreement, and civil service scientists. Thirteen new civil service scientists joined HSD in FY2010. They are Drs Joel Allred, Alex Glocer, Fred Herrero, Sarah Jones, Shri Kanekal, Emil Kepko, Georgia de Nolfo, William Paterson, Craig Pollock, Lutz Rastätter, Albert Shih, Lynn Wilson, and Yihua Zheng. Overall, the new hires are 64% are minority or female. HSD also has other student development programs to attract more young researchers to space science and retain the most promising candidates.



Growth of HSD in last 3 years

The Code 670 Team



James Slavin
Director of the NASA GSFC Heliophysics Science Division



Douglas Rabin
Deputy Director



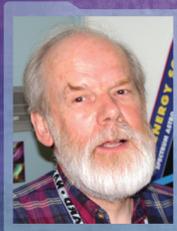
Michael Horn
Assistant Director



Holly Gilbert
Associate Director for Science



Robert McGuire
Associate Director for
Science Information Systems



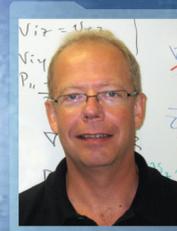
Brian Dennis
Chief - Code 671
Solar Physics Laboratory



Adam Szabo
Chief - Code 672
Heliospheric Physics Laboratory



Melvyn Goldstein
Chief - Code 673
Geospace Physics Laboratory



Michael Hesse
Chief - Code 674
Space Weather Laboratory



Chris St. Cyr
Senior Scientist



Joseph Davilla
Senior Scientist



Richard E. Hartle
Senior Scientist



Thomas Moore
Senior Scientist



John Sigwarth
Senior Scientist

HSD Facilities

The purpose of facilities is to enable the work of the scientists and engineers in HSD by providing a safe and comfortable working environment in a cost-effective manner.

One of the main barriers to achieving a more efficient HSD organization with good interdisciplinary communication was the distribution of our personnel throughout six buildings across GSFC. So last year HSD embarked on an ambitious program to consolidate all of our people into Building 21. By the end of FY2010, 82% of the group were resident in Building 21, and the rest are scheduled moved in by the end of the first quarter of FY2011 (achieved).

This endeavor was a major logistical challenge, requiring moving people out of

the building so their offices could be renovated and then back-filling others into that space. It required the moving of computers, telephones, and personal possessions without disrupting the schedule of our programs, science investigation, or community support while keeping costs under control.

Building 21 accommodates over 300 people (including co-located civil servants) in 169 offices. In addition to all the moves required by the renovation, old and dysfunctional furniture had to be replaced and the new furniture had to be customized to the needs of the individuals. The renovation teams are providing an excellent working environment to successfully accomplish our future programmatic and scientific goals. Most of the building now occupy their newly renovated offices.



Building 21 main entrance. Although B21 does not look as though it has changed much from the outside, the renovations inside will make a significant difference to the efficient functioning of HSD.



At the main entrance to Building 21 the first thing that you see is the HSD interactive science display with examples of past missions and instruments developed at GSFC as well as live updates showing the state of the Sun, solar wind, and magnetosphere (left). Even the hallways are beginning to be populated with some of our most spectacular images.



Some examples of the offices in HSD's renovated Building 21.

Here we see the new divisional offices (TLHC), a 3-person office (TRHC), and two layouts of 2-person offices before the occupants have taken up residence (bottom row). There are a few single-person offices (not shown here) for the most senior civil servants and program managers.

We have renovated or are in the process of renovating 16 laboratories in Building 21. By the end of FY2010, three labs were completed, and most of the rest will be finished by the end of FY2011. The people responsible for each individual laboratory have spent a lot of time working out their requirements and reviewing designs. Three conference rooms and a computer room have been renovated.

The whole process has been made possible by the dedication and hard work of a core team from Code 200 working closely with a core team from HSD.



Two laboratories undergoing renovation: A laboratory in the middle of the renovation process (left) contrasted to a completed laboratory (right)—from chaos to order. In these laboratories, we will develop and test innovative technologies and build new instrumentation to enable future NASA solar and space physics missions.

Code 200 Team



Luly Carson
ESB Backfill Manager



Catherine Chakola
Project Manager



Mark Daly
Project Manager



MaryEllen Ramsey
Project Manager



Shelly Simmons
Logistics



Holly Wrostek
Logistics



Van Yannas
Scheduler

Code 670 Team



Mike Horn
Assistant Director



Callie Booth
Administrative Officer



George Canter
Laboratory Manager



Cle Hunt
Laboratory Casework



Dale Humberson
Logistics



Linda Resh
Logistics



Marcello Rodriguez
Laboratory Casework

2010 Scientific Accomplishments

While it would not be practical to feature, in detail, all the scientific accomplishments of the HSD team in an annual report, a few outstanding examples of work that was successfully completed in FY2010 are presented in this section. A much more extensive summary of individual scientific contributions from members of the HSD team is given in Appendix A, and a comprehensive list of first author publications, coauthor publications, in-press articles and presentations can be found in Appendix B.

SDO Starts Operations in Time to Catch the Rise of Solar Cycle 24

Three months after it roared into orbit, SDO started its operational phase, which happened just in time to catch the rise of Solar Cycle 24. SDO, the first mission in NASA's Living With a Star Program, carries a suite of instruments designed to study how and why the Sun varies. SDO's EUV irradiance spectrometers measure the Sun's energy input to Earth, the magnetograph / helioseismograph measures the magnetic field and determines the structure and flows in the Sun's interior, and the telescopes provide images in the optical, UV, and EUV wavelength regimes. This suite of instruments allows SDO to study the Sun with unprecedented spatial, temporal, and spectral resolution.

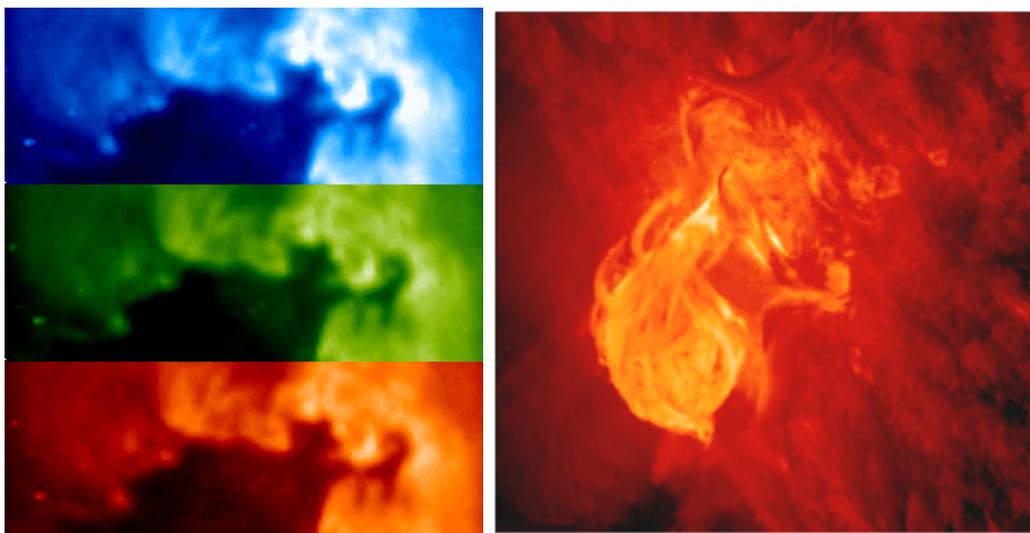


SDO's picture-perfect launch: February 11, 2010

GSFC and HSD have played a central role in all stages of SDO's development. HSD scientists led the formulation team, and GSFC designed and built the spacecraft and dedicated ground system. HSD's Dean Pesnell serves as the SDO Project Scientist, and Phillip Chamberlin and Barbara Thompson of HSD are SDO's Deputy Project Scientists. Additionally, a number of the HSD staff are *members of the science* investigation team and play roles in SDO's Education and Public Outreach activities.

During its 3-month commissioning phase alone, SDO took over 5 million high-resolution (16-megapixel) images of the Sun. After just 4 months of full operations in FY2010, we are already beginning to see the potential scientific bonanza that will result from the SDO mission as it works in concert with other solar missions like STEREO, SOHO, RHESSI, and SORCE.

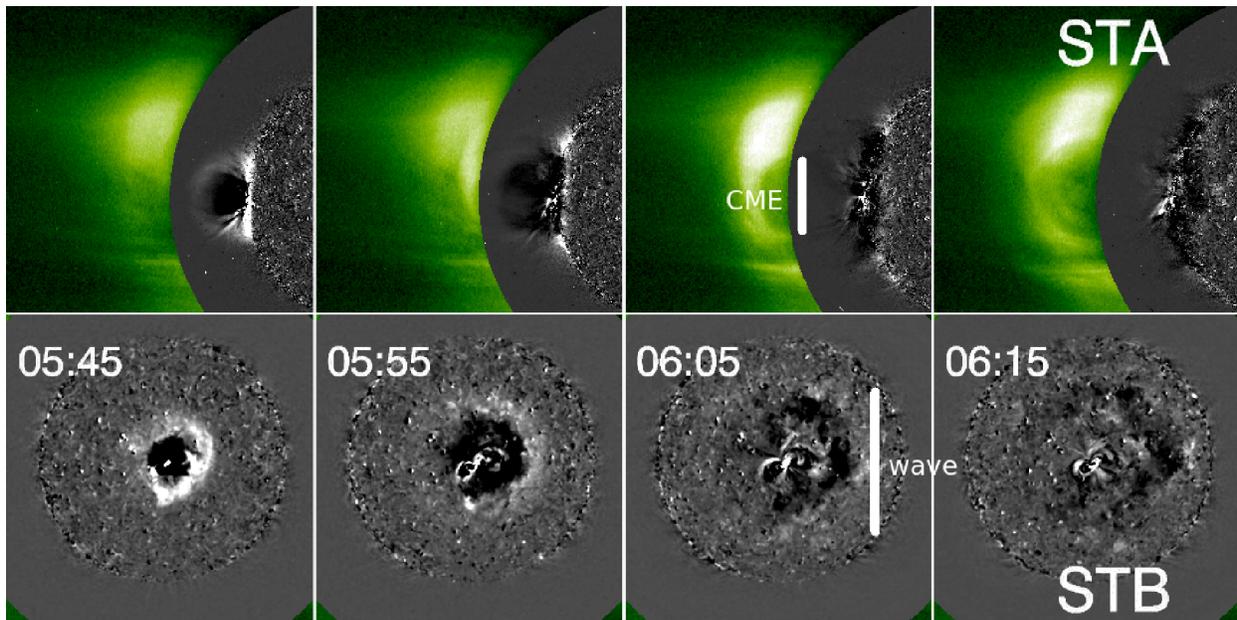
SDO has also been a major public relations success. For example, SDO videos on YouTube have had over 2 million hits, several major magazines have featured SDO as their cover stories, and for several hours SDO was the top story on cnn.com.



From microscale to macroscale: HSD scientists have been able to make advances in our understanding of solar turbulent processes as well as flare and CME energetics. Above left: Kelvin-Helmholtz vortices observed in multiple wavelengths on 2010 April 8. Above right: An M-Class X-ray flare and plasma surge on 2010 November 6.

STEREO and SOHO See Solar Activity Begin to Pick Up

The unusually long solar minimum has come to an end, as STEREO and SOHO have been able to observe an upswing in solar activity. Active regions, while still infrequent, have been spawning eruptive events such as CMEs. When the STEREO spacecraft were in quadrature (90° apart), it became possible to answer a question that solar physicists had been asking since low-coronal waves were first observed expanding outward from the active regions where CMEs originated in EUV images from SOHO in the late 1990's: Were the waves real, propagating disturbances or simply the “footprint” of the magnetic field disturbances connected with the expanding CMEs?



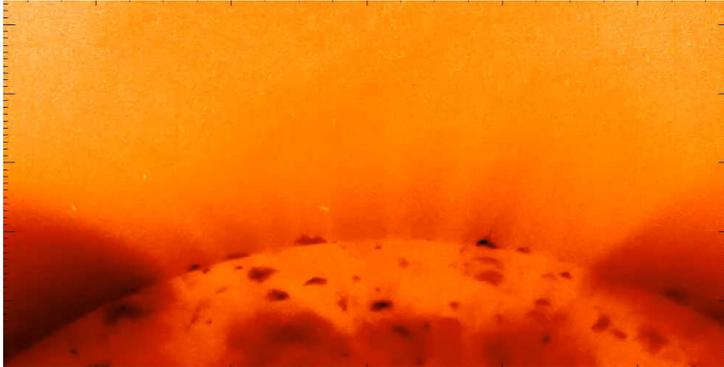
Observations from STEREO Ahead's SECCHI COR1 coronagraph (green-white color table) and EUVI difference images (grey scale). Bottom: simultaneous difference images from STEREO Behind's EUVI. By 06:05 UT, the compression wave seen in the EUV expands well beyond the scale of the of the dark CME cavity.

Observations from the EUV Imagers (EUVIs) and the GSFC 670-built COR1 white-light coronagraphs on the STEREO Ahead (A) and Behind (B) spacecraft make it clear that the EUV waves are indeed fast-mode magnetohydrodynamic waves. At least three different methods have been used to triangulate CME front locations and predict their passage times at 1 AU from STEREO observations. As the STEREO spacecraft approach opposition (180° separation), which will occur during the halftime show of the 2011 Super Bowl, we will have our first complete views of the Sun's surface and corona, as well as in situ sampling of the solar wind energetic particles in the half of the heliosphere farthest from the Earth.

Both STEREO and SOHO were rated “Excellent” in their contribution to heliophysics system observatory by the Senior Review of Heliophysics missions held in the spring of 2010, and both were extended at least until the end of fiscal year 2013. Some of the instruments on SOHO are being retired, but the observatory is continuing to supply white-light coronagraphy from the LASCO instrument in support of SDO. To do so, SOHO mission operations have been almost entirely automated. The LASCO coronagraph will be operated by Code 670 personnel.

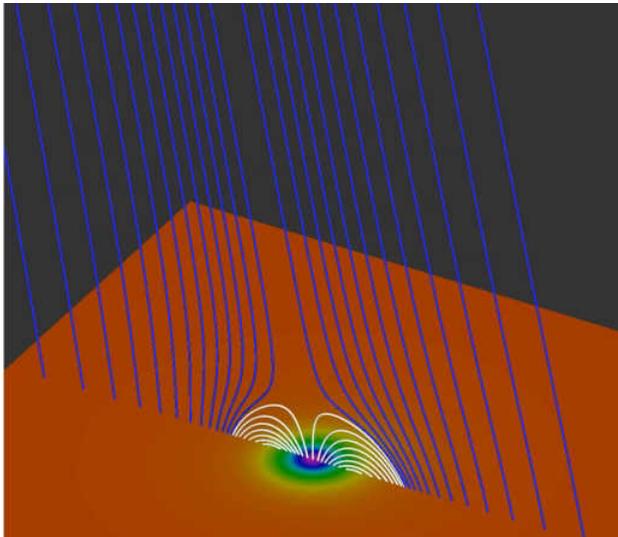
Advances in MHD Modeling of Coronal Jets

Coronal jets are the largest example of the transient plasma ejections that are observed throughout the Sun's atmosphere. Jets and their smaller cousins, spicules, have long been proposed as the basic process by which heat and mass are injected into both the corona and solar wind. Among the new results from Hinode are the findings that jets are more common than previously believed, reach higher speeds, ~ 1000 km/s, (on order of the Alfvén speed), and can be quasi-homologous in that they frequently reoccur from the same source region.



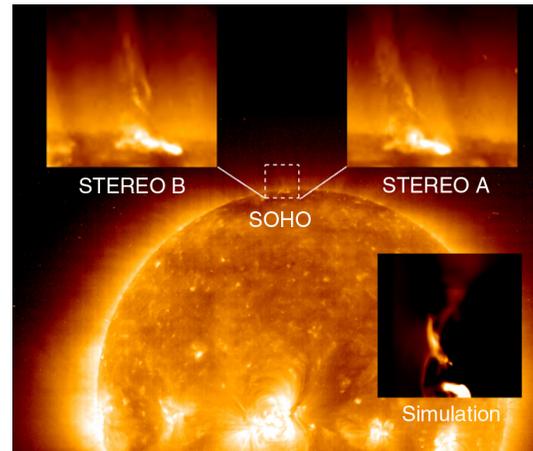
Jets in a polar coronal hole showing reoccurrence (Hinode)

The middle image shows the jet as seen by SOHO. A model for solar jets and related transients has been developed, in which the acceleration is due to magnetic reconnection between the closed field of a small bipolar region and surrounding large-scale flux. The key new feature of the model is that the reconnection is driven by the buildup of magnetic twist in the closed field region, resulting eventually in a kink-like instability that drives a large burst of fast reconnection.



Quasi-homologous eruptions of field lines (white and blue) and mass density (red isosurface) initially and near the peak of the third jet acceleration. Note the helical structure of the reconnected field lines.

Furthermore, the two STEREO spacecraft discovered that jets can exhibit a twisting motion. STEREO's two views (left and right) of a jet that erupted from the Sun's outer atmosphere in June 2007 show a twisted structure (orange), an indication that tangled magnetic fields propelled the jet. White indicates bright structures at the jet's base.



Simulations with our adaptive mesh refinement 3D MHD code have verified that this mechanism can produce both the observed jet speeds and helical structure. Recently, we have shown that continued twisting of the field results in quasi-homologous ejections that closely resemble the Hinode jet observations.

RHESSI Observes Coronal Collision

The primary goal of the RHESSI mission is to understand the energy release processes associated with solar flares. To do so, it is often useful to study eruptive events that occur on or near the solar limb when the bright hard X-ray footpoints are occulted by the solar disk. This allows observations to be made of the fainter emission in the corona that is most probably closer to the actual energy release site itself. During one such event that occurred on 2007 January 25, RHESSI observed two coronal X-ray sources (believed to be a plasmoid and a looptop source) that appeared to merge at the onset of the flare. A number of similar plasmoids (or “above-the-looptop” sources) have been observed by RHESSI over the years, but this was the first to *decrease* in altitude during the flare. According to recent numerical simulations, such a merging or “collision” of two plasmoids should have other distinct observational signatures.

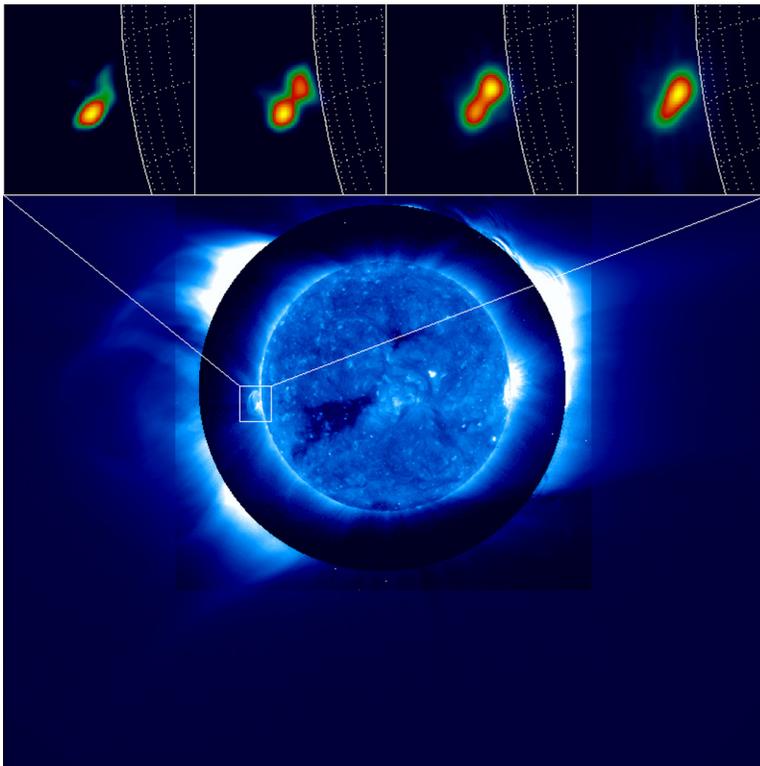
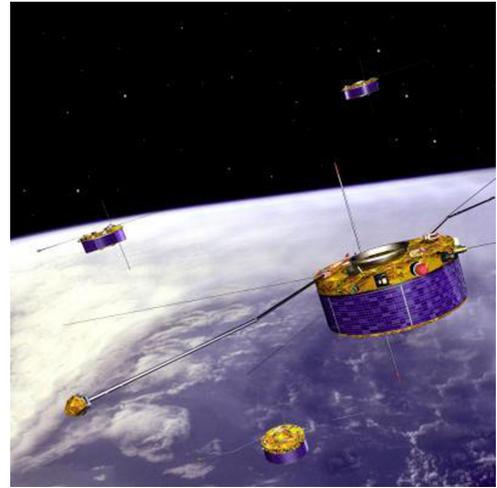


Image of the CME as viewed from STEREO. The insets show the merging of the two X-ray sources along the current sheet as seen with RHESSI.

From the RHESSI lightcurves, and those from the Learmonth Radio Telescope in Australia, there appeared to be increased hard X-ray and radio emission at the time of the merging, suggesting that a secondary episode of particle acceleration had taken place. Furthermore, the merging was also temporally correlated with the acceleration phase of the associated CME as determined from STEREO observations. In accordance with the simulations, this suggests that both the CME and the flare were driven by the same energy release process in the coronal current sheet, most probably initiated by magnetic reconnection. The study of X-ray sources in the corona is therefore crucial in gaining an understanding of the magnetic reconnection and particle acceleration processes during solar flares, and by combining RHESSI observations with those from STEREO we can learn more about the relationship between flares and CMEs, rather than treating them as disparate events.

Cluster Helps Disentangle Turbulence in the Solar Wind

Surrounding the Sun is a roiling wind of electrons and protons that shows constant turbulence at every size scale: long streaming jets, smaller whirling eddies, and even microscopic movements as charged particles circle in miniature orbits. Through it all, great magnetic waves and electric currents move through, stirring up the particles even more. This solar wind is some million degrees Kelvin, and can move as fast as 750 km/s. The solar wind is hotter than expected, but the exact reasons remain elusive. Now, Cluster mission has provided new data about how the protons in the solar wind are heated.



The Cluster quartet of spacecraft. (ESA)

Recently, there was a perfect window of 50 minutes when the four Cluster spacecraft were so close together they could watch movements in the solar wind at a scale small enough that it was possible to observe the heating of protons through turbulence directly for the first time. Scientists know that large turbulence tends to “cascade” down into smaller turbulence. It is also known that somehow the magnetic and electric fields in the plasma must contribute to heating the particles. Decades of research on the solar wind have been able to infer the length and effects of the magnetic waves, but direct observation was not possible before Cluster observed large waves from afar. These start as long-wavelength fluctuations, but lose energy while getting shorter. Loss of energy in the waves transfers energy to the solar wind particles, heating them up, but the exact method of energy transfer, and the exact nature of the waves doing the heating, has not been completely established.

In addition to trying to find the mechanism that heats the solar wind, there’s another mystery: Depending on their wavelengths, the magnetic waves transfer heat to the particles at different rates. The largest waves lose energy at a continuous rate until they make it down to a wavelength of about 100 km. They then lose energy even more quickly before they hit a wavelength around 2 km and return to the previous rate. To address this, scientists used data from Cluster when it was in the solar wind in a position where it could not be influenced by Earth’s magnetosphere.

The Cluster measurements showed that the cascade of turbulence occurs through the action of a special kind of traveling waves, Alfvén waves. The surprising thing about the waves that Cluster observed is that they pointed perpendicular to the magnetic field. This is in contrast to previous work from the Helios spacecraft, which in the 1970s examined magnetic waves closer to the Sun. That work found magnetic waves running parallel to the magnetic field, which can send particles moving in tight circular orbits, the cyclotron resonance process, thus giving them a kick in both energy and temperature. The perpendicular waves found here, on the other hand, create electric fields that efficiently transfer energy to particles by, essentially, pushing them to move faster.

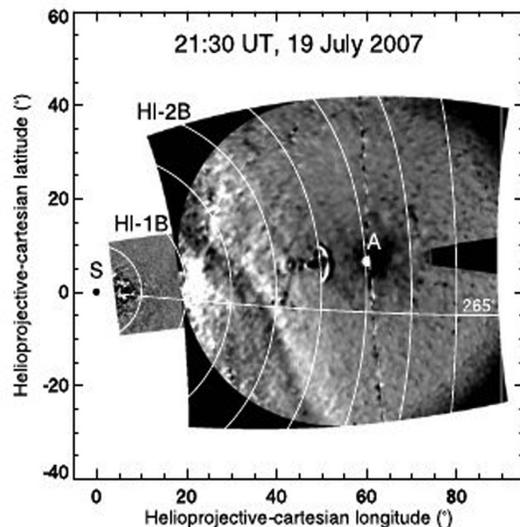
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STEREO Discovers Origin of Solar Wind Ripples

The early white-light images of the solar wind recorded by STEREO revealed the recurrent passage near 1AU of large-scale density waves (see Figure). It was found that these density ripples did not originate from CMEs. The field of view of the coronal imager is sufficiently wide that the 3D trajectories of these waves could be computed from simple geometrical calculations. With a combination of the trajectories and in situ measurements the nature of these ripples could be derived; they corresponded to the passage of slow plasma that was swept up and compressed into high-density regions by faster solar wind.

Part of a new analysis tool exploits a widely used mapping technique called “J-maps” which are constructed by extracting the intensity variation in a band of pixels distributed along the ecliptic plane from a series of composite running-difference SECCHI images, and plotting this variation as a function of the angle away from the Sun. The ripples are seen in these maps as leading white/trailing black tracks. The measured elongation variation of these density ripples can be used to determine their 3D trajectory. Conversely, knowledge of the time of impact and speed of a density structure measured in situ by a spacecraft, located at a known position relative to the white-light observer, can be used to compute the expected elongation variation of that structure in a J-map. A match between the observed and predicted tracks establishes the link between the white-light observations and the in situ measurements.

This tool was used to search for the solar origin of short magnetic field rotations that are frequently measured in situ inside the high-density region associated with the wave. These transients were found to originate near the Sun in small plasma ejections that are poorly resolved in coronagraph images. These ejections often appear as small arches and are continually expelled from the well-known coronal “helmet streamers.” The high frequency of these ejections (two or three per day) contributes largely to the variability of the slow solar wind and are, in the lower corona, the origin of the ripples. These small ejections are detected in situ as small transient magnetic field orientations that deviate from the Archimedean spiral, which forms the quieter solar wind. These transients are formed by the process of magnetic reconnection occurring near the tip of helmet streamers where oppositely directed magnetic fields meet equivalent to the formation of plasmoids in the tail of the magnetosphere.

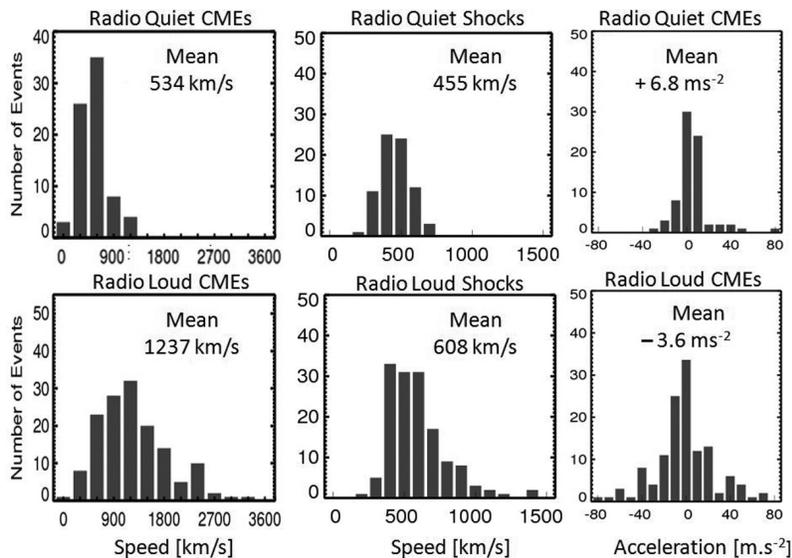


A composite of HI-1B and HI-2B difference images from 2007 July 19 during the passage of the plasma density wave. The location of STEREO-A (A) is shown in the HI-2 difference image. Earth is located very close to STEREO-A in the HI-2B fov. S marks the location of the Sun.

Coronal Mass Ejections Organize Interplanetary Shock Properties

The driver of Interplanetary shocks was in doubt until a study involving more than 200 IP shocks detected by the SOHO, Wind, and ACE spacecraft, identified the driving force behind the apparently “driverless” IP shocks to be CMEs. While most of the driverless shocks were due to limb CMEs, a few had their CME sources close to the disk center of the Sun. In these cases, it was discovered that coronal holes pushed the CMEs away from the Sun-Earth line, so they behaved like limb CMEs.

One way to find out whether a CME drives a shock is to look at its radio emission properties. CME-driven shocks emitting type II radio bursts are known as “radio-loud” events as opposed to radio-quiet events in which the shocks do not produce the bursts. Starting with over 200 shocks detected at L1, the associated CMEs were grouped into radio-loud and radio-quiet events. When the CME properties were compared for the two groups, significant differences were found.



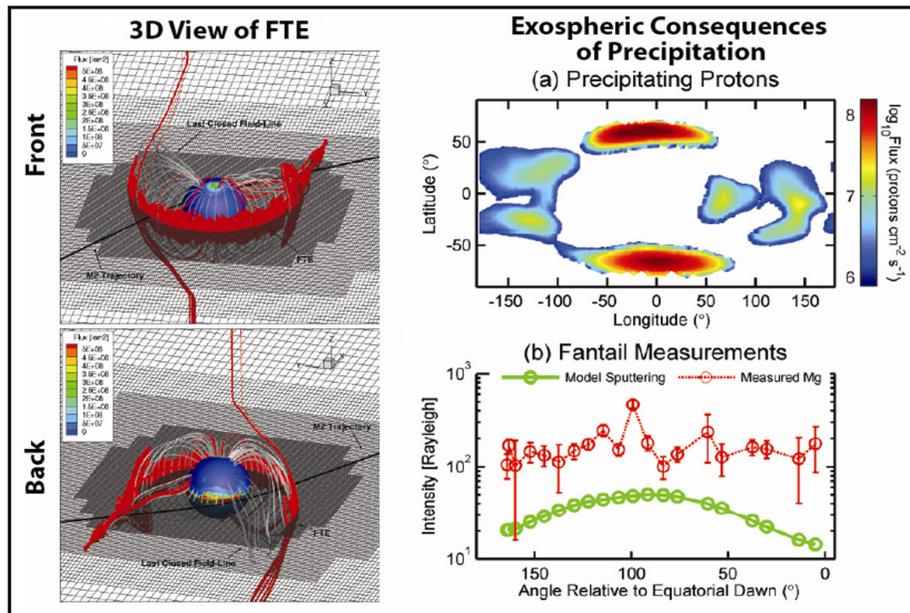
(left) CME speeds, (middle) IP shock speeds, and (right) CME accelerations for (top row) radio quiet and (bottom row) radio loud events. CMEs associated with radio-loud and radio-quiet shocks have distinct CME speeds and opposite signs of acceleration. The radio-loud and radio-quiet shocks have similar speeds.

The CME speeds were very different for the radio-loud and radio-quiet CMEs, while the corresponding IP shock speeds were similar for the two groups. The difference between radio-quiet and radio-loud events seems to be erased as the CMEs propagate into the interplanetary medium because of the momentum exchange between the CMEs and the ambient solar wind. Another significant difference was that the radio-quiet CMEs accelerated on the average, while the radio-loud CMEs decelerated. In general, the radio-loud CMEs drove shocks near the Sun, which weakened as they propagated into the IP medium. Among the radio-loud CMEs, some were radio loud only near the Sun, some only near Earth, and others throughout the IP medium. The heliocentric distance range over which the radio emission occurred essentially depended on the CME speed.

MESSENGER Probes Magnetospheric Variability at Mercury

Last year, MErcury Surface, Space ENvironment, GEOchemistry, and Ranging (MESSENGER) completed its third and last Mercury flyby prior to orbital insertion in March 2011. Flyby findings ascertained that, although Mercury's intrinsic field appears to be unchanged since the days of the Mariner 10 encounters, its magnetosphere is extremely variable and is much more responsive to the Interplanetary Magnetic Field (IMF) direction and dominated by the effects of reconnection than that of Earth or the other magnetized planets. Signatures of reconnection of the IMF with the planetary magnetic field, such as large Flux Transfer Events (FTEs), plasmoids, traveling compression regions, and magnetotail loading-unloading cycles, were repeatedly observed by the MESSENGER Magnetometer (MAG).

With the magnetosphere being so “open,” solar wind ion access to the surface has long been hypothesized to constitute an important source of Mercury's neutrals and ions. The Ultraviolet and Visible Spectrometer (UVVS) onboard MESSENGER observed exospheric Na, Ca, and Mg atoms and exo-ionospheric Ca^+ ions that populate the magnetotail. The combined particle and field observations suggested not only that the solar wind may have measurable exospheric consequences, but also that the associated heavy planetary ions may be sufficiently abundant to affect magnetospheric properties. MESSENGER orbital phase measurements and modeling of the flyby measurements promise to determine, among others, whether Na^+ and Ca^+ ions of planetary origin may modify the formation of Kelvin-Helmholtz vortices and participate in the development of a planetary ion boundary layer surrounding the magnetopause.

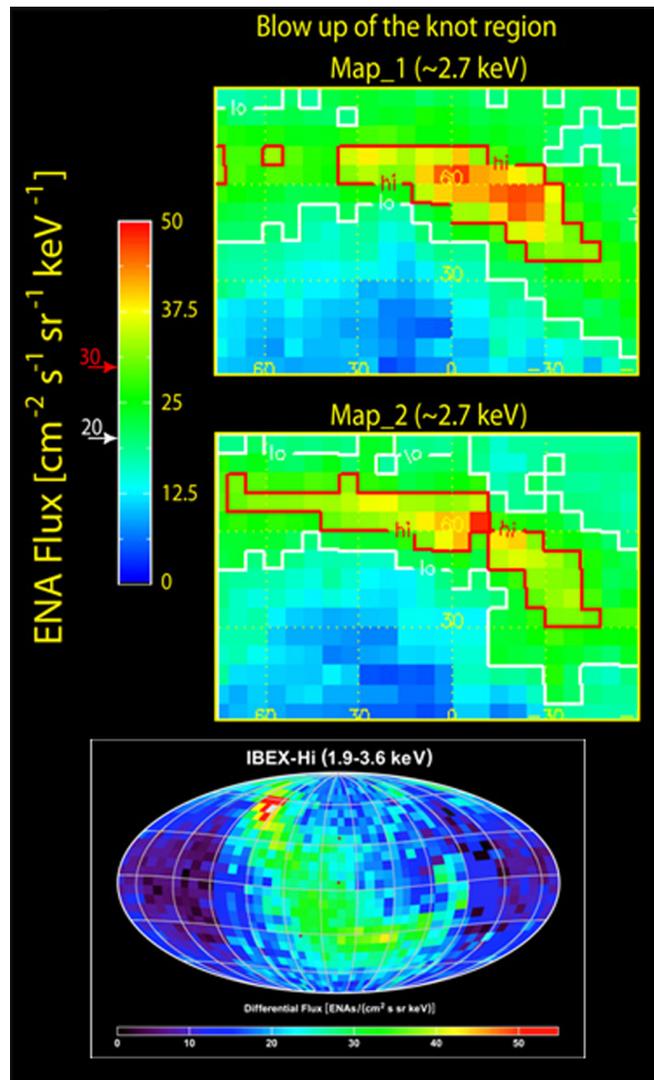


A model (left) of a Flux Transfer Event (in red) forming at Mercury corroborates the MESSENGER finding that Hermean FTEs are large (diameter of 1 Mercury-radius). Exosphere models (right) suggest that the solar wind sputtered component likely accounts for an appreciable fraction of the neutral Mg that was discovered during MESSENGER's second flyby.

A New Surprise from the Interstellar Boundary Explorer

IBEX is a Small Explorer that was launched in October 2008 and designed to measure Energetic Neutral Atoms (ENAs) generated at the edge of the solar system. The first all-sky map of ENAs, released in 2009, startled heliospheric scientists because it showed a bright ribbon of ENA emissions that was not predicted by any theory or model. The ribbon appears to be ordered by the direction of the local interstellar magnetic field, and, although there are theories, there is still no consensus on how the magnetic field outside the heliosphere imprints itself on the ENA intensities. The ribbon also contains a bright “knot” of emission that is most obvious at the higher IBEX energies (bottom panel of figure shows full-sky map).

IBEX continues to accumulate new maps of the ENA sky every 6 months. The second map also had a surprise. Although the large-scale structure of the ribbon is stable between the two maps, there are some remarkable changes showing that the heliosphere has evolved over the 6-month period. The overall emission of ENAs is lower in the second map, especially at the two poles, possibly because of a weakened solar wind that has been seen by other spacecraft. In addition, the knot is less bright and it appears to have spread, as shown in the top panel (first map) and middle panel (second map). The large-scale stability and systematic changes at smaller spatial scales provide important new information about the outer heliosphere and its global interaction with the galaxy. These results are from the IBEX Science Team and are in press in the *Journal of Geophysical Research*.



HSD Honors and Awards

In FY2010, members of HSD won a large number of honors both internal to NASA and from external organizations. In addition, HSD has a peer award system in which members of the group are nominated and selected by their peers for an annual award. The awards won by members of HSD in FY2010 include:

- Dave Sibeck (674) was selected for an Excellence in Scientific Achievement award
- Tom Moore won an Excellence in Service award
- Michael Hesse was elected an AGU fellow
- Mike Horn earned a management award
- Spiro Antiochos and Joe Davila won leadership awards
- Adolfo Vinas was given an award for mentoring
- Zoe Rawlings and Callie Booth were given Professional Administrator awards
- Callie Booth, Traci Rosnack, George Canter, Vladimir Osherovich, F. Bruhweiler, Alex Glocer, Vasant Patel, Joe Hourcle, F. Hunsaker, Joshua Malinowski, Linda Resh, Tom Narock, Jan Merka, and Len Burlaga all won peer awards.

Proposals Won

HSD was awarded a number of new research grants under the ROSES 2009 opportunity:

GSFC-Led Proposals	
Proposal Title	PI Name
Ion/Neutral Coupling in Solar Prominence Structure and Dynamics	Holly Gilbert
Nanoflares, Spicules, and the Source of Coronal Plasma	Jim Klimchuck
Multispacecraft Studies of the Origin and Evolution of the Slow Solar Wind with Predictions for Inner Heliosphere Probes	Aaron Roberts
The Dynamics of Neutral-Line Flows During CMEs and Flares	Peter Schuck

HSD also participated with members of the heliophysics community as Co-Is on a number of successful proposals for the 2010 opportunity:

GSFC Co-I Proposals			
Proposal Title	PI Name	PI Institution	GSFC Co-I
Integrated Solar probe Imaging Suite	Dame McComas	SWRI	Eric Christian
The Focusing Optics X-ray Solar Imager (FOXSI)	Sam Krucker	UCB	Steven Christe
Investigation of the Low-Energy Cutoff in Solar Flares	Jack Ireland	ADNET	Gordon Holman

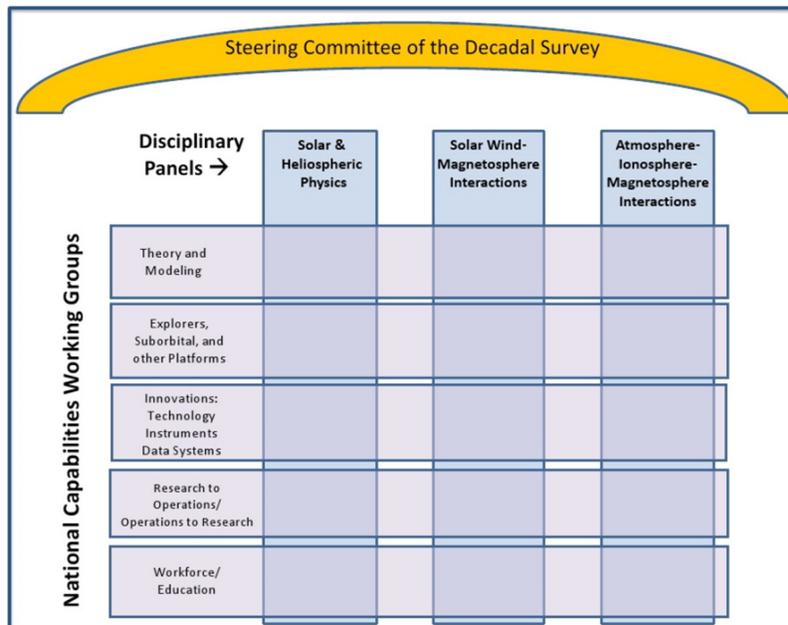
HSD Support of the Decadal Strategy for Solar and Space Physics

The Space Studies Board of the National Research Council is conducting a broad-based assessment (“decadal survey”) of the scientific priorities of the U.S. solar and space physics research enterprise for the period 2013 – 2022. In conducting this assessment, there will be an emphasis on developing a systems approach to the theoretical, ground-based and space-based research programs that comprise the flight programs and focused campaigns of NASA, the ground-based and basic research programs of NSF, and the complementary operational programs of other agencies such as NOAA. This new decadal survey will update and extend the NRC’s previous survey in solar and space physics, “The Sun to the Earth and Beyond: A Decadal Research Strategy in Solar and Space Physics” (2003). The survey committee, informed by three study panels that will also be established by the Board and supplemented by informal working groups, will broadly canvass the field of solar and space physics and:

- Provide an overview of the science and a broad survey of the current state of knowledge in the field, including a discussion of the relationship between space- and ground-based science research and its connection to other scientific areas
- Identify the most compelling science challenges that have arisen from recent advances and accomplishments
- Identify—having considered scientific value, urgency, cost category and risk, and technical readiness—the highest-priority scientific targets for the interval 2013-2022, recommending science objectives and measurement requirements for each target rather than specific mission or project design/implementation concepts
- Develop an integrated research strategy that will present means to address these targets.

HSD will support the Decadal Survey in several ways:

1. HSD scientists hold positions within the formal structure of the Survey, illustrated in the figure. M. Hesse (674) is a member of the Steering Committee as well as Co-Leader of the Working Group on Research to Operations/Operations to Research. S. Antiochos (674) is Vice Chair of the Panel on Solar and Heliospheric Physics. R. Pfaff (674) is a member of the Panel on Atmosphere-Ionosphere-Magnetosphere Interactions. L. Kepko (674) and R. Pfaff are members of the Working Group on Explorers, Suborbital, and Other Platform.



2. HSD scientists have contributed as lead author or co-author to 24 of the White Papers, an integral part of the Survey process by which members of the heliophysics community can articulate their scientific priorities. HSD lead authors include:
- T. Moore (670), “Laboratory for Active Space Experiment Research (LASER)”
 - T. Moore (670), “Mechanisms of Energetic Mass Ejection”
 - O. C. St. Cyr (670), “Space Weather Diamond: A 10x Improvement in Real-Time Forecasting”
 - O. C. St. Cyr (670), “Solar Orbiter: Exploring the Sun-Heliosphere Connection”
 - K. Strong (670), “4PI: A Global Understanding of the Solar Cycle”
 - S. Christe (671), “The Focusing Optics X-ray Solar Imager (FOXSI)”
 - J. Davila (671), “Understanding Magnetic Storage, Reconnection, and CME Initiation”
 - J. Davila (671), “The International Space Weather Initiative (ISWI)”
 - N. Gopalswamy (671), “Earth Affecting Solar Causes Observatory (EASCO): A New View from SunEarth L5”
 - J. Klimchuk (671), “Maximizing NASA’s Science Productivity”
 - A. Shih (671), “Solar Ion Acceleration and the Flaring Atmosphere”
 - E. Christian (672), “Heliophysics Instrument and Technology Development Program (HITDP)”
 - J. Cooper (672), “Space Weathering Impact on Solar System Surfaces and Mission Science”
 - D. A. Roberts (672), “The Heliophysics Data Environment as an Enabler of HP Science of the Next Decade”
 - A. Szabo (672), “Energetic Particle Propagation and Coronal Mass Ejection Evolution in the Inner Heliosphere: Multi-point in-situ Solar Sentinels Observations”
 - A. Szabo (672), “Solar Wind Kinetic Physics: High Time Resolution Solar Wind Measurements from the DSCOVR Mission”
 - J. Dorelli (673), “Computational Heliophysics Innovation Program (CHIP)”
 - S. Fung (673), “MAGnetosphere-Ionosphere Connector (MAGIC): Investigation of Magnetosphere-Ionosphere Coupling from High-to-Low Latitudes”
 - L. Kepko (674), “Magnetospheric Constellation”
 - L. Kepko (674), “A NASA-funded CubeSat Program”
 - R. Pfaff (674), “Understanding Geospace on a Grand Scale: The Global Ionosphere/ Thermosphere Constellation”
 - R. Pfaff (674), “Sounding Rockets as Indispensable Research Platforms for Heliophysics Research and Development of a High Altitude Sounding Rocket”
 - D. Rowland (674), “The Tropical Coupler Mission”
 - S.E. Kanekal (672), “Advancing our Understanding of magnetospheric, Solar Energetic Particle, and Cosmic Ray Physics: A proposed Mission to LEO”
3. HSD scientists are expected to support several brief studies of mission concepts that emerge from the Survey process. NASA/HQ will select the concepts and make study assignments to GSFC and other field centers.

Education and Public Outreach

Educating and inspiring students, teachers and the public by communicating the advances in heliophysics science is the primary goal of the HSD Education and Public Outreach (E/PO) staff. Dr. Holly Gilbert, Associate Director for Science, leads the effort to coordinate and advance the most effective methods to reach an array of audiences. All programs and projects are designed to meet or surpass NASA Education Office and SMD E/PO requirements, which include attention to quality, partnerships, focus on customer needs, sustainability, and diversity.

A facilitated HSD E/PO retreat in November 2009 helped determine and focus the direction of the group. Along with E/PO specialists, monthly E/PO meetings are attended by representatives of the GSFC Education and Public Affairs Offices, including the HSD science writer. As a result, communication among these groups—and E/PO staff—has improved considerably, leading to more efficient and effective support for each other in all directions.

Division E/PO staff possess a wide range of talents and depth of experience. With specialists in science, formal and informal education, public outreach, web content and design, social media, graphic design, and many other areas, the staff are well equipped to fulfill their goal. E/PO Leads for STEREO, SOHO, SDO, MMS, Hinode, and ACE, and the entire Sun-Earth Day team are at GSFC, which has provided many opportunities for coordination and leverage. Another key to the team's success has been the involvement of enthusiastic HSD scientists who have directly interfaced with audiences, verified scientific content, or provided data access or other resources.

Strategic coordination and collaboration within HSD, as well as with other GSFC and NASA programs, universities, and other institutions, expanded the impact and made optimum use of available resources. Interactions both at higher organizational levels and with other Divisions are now routine. Dr. Gilbert is the Division representative to the GSFC PEEC Committee (Public Engagement and Education Communications) and Education Policy Team, and she interfaces with the Science Exploration Directorate E/PO Lead. HSD is represented in Goddard's Science Communications Working Group, and the E/PO team contributes to telecons and meetings with the SMD Heliophysics E/PO Forum and the GSFC Education Implementation Team. Staff also network with the GSFC Astrophysics Division E/PO team, with a representative at weekly meetings and on monthly Astrophysics E/PO Forum telecons. Pertinent information is regularly shared between the Divisions. This year, HSD E/PO staff were called upon by ASD to review proposals before submission and to provide materials for ASD E/PO events.

Team coordination and collaboration has resulted in many important accomplishments in the last year beyond those listed in the next section: development of new proposal ideas, teams, and reviews; new connections between scientists and E/PO projects and staff; better distribution of funding to maintain programs and talent; greater knowledge of resources available inside and outside HSD; and clearer understanding of NASA requirements. As a group, we also supported two Goddard-wide events, the Science Jamboree and E/PO Open House.

Programs

Advanced Student Research

Through summer intern programs, such as the High School Internship Program, heliophysicists supported many summer interns (high school and undergraduate), in addition to several graduate students through the Graduate Student Summer Program. HSD supported two students in the

Cooperative Education Program, an important educational link between college-level academic study and full-time meaningful work experience through a working agreement between GSFC and several educational institutions. The Graduate Student Researchers Program (GSRP) provides qualified graduate students, in residence at their home institutions, with fellowship support on research projects of mutual interest to the student and the GSFC mentor; in FY2010 HSD supported eight GSRP students. The NASA Postdoctoral Program (NPP) provides talented postdoctoral scientists and engineers with valuable opportunities to engage in ongoing NASA research programs; HSD currently has 14 NPP staff members and several other postdoctoral scientists funded through science grants.

K-12 Education and Public Outreach

Sun-Earth Day (SED) remains the HSD E/PO program with the widest reach, and it covers the range of formal and informal education and outreach activities and resources. SED is a series of programs and events highlighting HSD scientists, missions, and research that occur throughout the year and culminate in a celebration at the spring equinox. This year’s theme was Magnetic Storms. SED reached 650,000 people through direct and indirect participation and another 3.5+ million through the website.

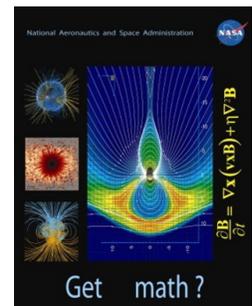
SED produced podcasts, vodcasts, and other multimedia and print resources for use by their audiences internationally, in collaboration with heliophysics missions and scientists, NASA EDGE, National Science Teachers Association (NSTA), and science centers and museums around the world. The program also provided professional development to K-12 educators, museum personnel, amateur astronomers, and community groups. Over 26,000 registered participants used the resources in their own outreach programs. The program also took full advantage of social media networking opportunities to encourage discussions and user feedback, provide instant program updates, and link to related NASA social networks, with over 3,000 Facebook fans and 2,000 Twitter followers.



On March 20, SED hosted a live webcast from the NSTA conference, along with the award-winning NASA EDGE team known for their offbeat, funny, and informative look behind the NASA curtain; speakers included Dr. Gilbert and other heliophysics scientists and E/PO specialists. The webcast alone has since received over a million downloads.

K-12 Education

Visitors to the SpaceMath@NASA website have downloaded over 2 million math problems since the site began, and it currently receives 10,000 visitors monthly. Funded by an EPOESS award, the site is a collection of 375 astronomy and space science problems featuring NASA science discoveries. The program has extensive partnerships with SMD missions who want to increase their mathematics offerings in E/PO. It was recently redesigned to include more multimedia resources, as well as NASA eClips video programs with math extensions. New math problems are added to the site several times each week, often tied to SMD science and engineering press releases. SpaceMath is also producing monthly math problems for NASA’s Year of the Solar System program. Six new hard-copy math guides, including “Earth Math,” “Space Weather Math,” and “Electromagnetic Math,” were also published this year.



The **Space Weather Action Center** (SWAC) complements SED and lets students monitor online the progress of a solar storm from the Sun to the Earth. Following a guide, they can quickly access, analyze, and record actual NASA satellite and observatory data to create space weather news reports. Three thousand educators now use SWAC. With support from an EPOESS award, a new Challenger Center “scenario” was developed this year where students react to a simulated solar storm during an Earth, Moon, or Mars mission. The SWAC team trained staff from 20 Challenger Centers on this project, which also provides a post-visit classroom activity.

SDO sponsors formal education programs, including “A Day at Goddard,” a field trip exposing students to a range of NASA career options and the opportunity to meet scientists and engineers. “SDO Ambassador in the Classroom,” a partnership with NASA’s Aerospace Education Services Project, brings a scientist or E/PO staff into the classroom to share SDO-related science lessons.

“Think Scientifically” is a series of three books discussing solar science topics at the elementary level. Each was written by a classroom teacher with SDO staff, and illustrated by an interning artist, and includes science, reading, math, and language arts lessons. The books were released this year and are now being pilot tested in 10 classrooms in Pennsylvania, Maryland, and Washington, DC.

Informal Education

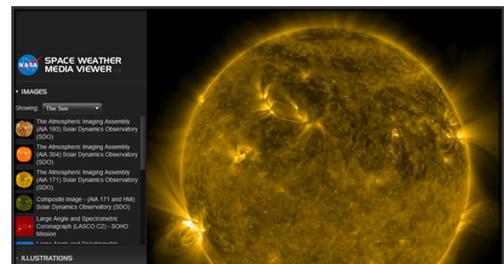
“Family Science Night,” a program for middle school students and their families, is a partnership with the GSFC Astrophysics Division. Evaluation continues to show that participants have a positive change in attitude toward science and can relate what they learn to their everyday lives. On average, 90% of families reported that they conducted science-related activities as a family between workshops and as a result of the program, which is now running in five locations in the northeast.



SDO had a booth at the Association of Science and Technical Centers conference that featured SDO highlight clips on a large plasma screen display and provided information about SDO’s new “kiosk” mode, which allows easy presentation of the previous 48 hours of solar activity at museums.

Public Outreach

The “Space Weather Media Viewer” (SWMV) provides to anyone on the web the same views of the Sun used by scientists to study it. Visitors can zoom in on near-real-time satellite images to see solar activity as it happens. The site also provides images, mission information, video simulations, and scientist interviews. All videos are broadcast-quality and can be downloaded. Recent updates to the Viewer include SDO data and new visualizations and video clips.



SDO E/PO professionals also designed and implemented a comprehensive social media program that includes Twitter, Facebook, YouTube, Flickr, and Blogspot to create a community of mission followers and a feedback mechanism for online SDO E/PO products. A social media plan and style guide, along with a data collection mechanism, was completed this year to develop a cohesive structure for SDO’s social media offerings.



HSD E/PO specialists and scientists reached over a thousand minority students and faculty this year, providing heliophysics educational materials to high school students in weather camps at Howard University, K–12 teachers from the Bureau of Indian Education and at Gallaudet University (partnering with DC Space Grant), teachers of gifted and talented students at Loyola University in Baltimore, tribal college students and faculty members at a summer institute in North Dakota, and Title I students and teachers at the Virginia Air and Space Center. Thanks to support from an EPOESS grant, staff also trained faculty from the City University of New York/Medgar Evers College on SWAC.

Cosmicopia is ACE's high-school level public cosmic ray and heliospheric science website, which includes over 400 unique "Ask Us" questions and answers. It saw a 30% increase in monthly accesses (now averaging over 500K) and a 25% increase in unique users in the last year.

AstroZone (held at AAS), a.k.a. "Exploration Station" (at AGU), is a science open house designed to share NASA hands-on science activities with local families. The program is a partnership between SDO and the Insight Lab at the Rochester Institute of Technology Center for Imaging Science. HSD scientists and engineers also supported an outreach booth at this year's "Maryland Day" at the University of Maryland in College Park.

Public Affairs

In March 2010 HSD welcomed Susan Hendrix as the heliophysics PAO team lead. Susan comes to us with extensive media and public engagement experience. In September 2010 Karen Fox joined HSD as the new science writer/story development lead. She has more than 12 years of freelance writing experience and a strong science background. Other highlights include Apple's release of a new 3D iPhone App in February, which features STEREO mission data, offering viewers never before seen images of the Sun.

Dr. Gilbert, along with a few other HSD scientists, has made several appearances for national media, including Discovery, National Geographic, and History channels, and local news. GSFC also has the Scientific Visualization Studio (SVS) producing superior quality images, animations, and data visualizations for a wide range of heliophysics communications and science activities, including press releases, live presentations, print publications, television, and video documentaries.

Notable FY2010 heliophysics stories include:

- "SDO First Light press conference" (4/21/10)
<http://svs.gsfc.nasa.gov/vis/a010000/a010500/a010551/index.html>
- "NASA's New Eye on the Sun Delivers Stunning First Images" (4/21/10)
http://www.nasa.gov/mission_pages/sdo/news/first-light.html
- YouTube video released in conjunction with SDO First Light (389,432 views, third most for Goddard EVER)
<http://www.youtube.com/watch?v=QrmUUcr4HXg>
- "Space Weather Turns Into An International Problem" (7/16/10)
http://science.nasa.gov/science-news/science-at-nasa/2010/16jul_ilws/
- "Spacecraft Observes Coronal Mass Ejection" (8/04/10)
<http://www.nasa.gov/topics/solarsystem/sunearthssystem/main/News080210-cme.html>
- "IBEX finds surprising changes at solar boundary" (9/30/10)
http://www.nasa.gov/mission_pages/ibex/news/solar-boundary.html

HELIOPHYSICS E/PO ON THE WEB

A Day at Goddard: <http://sdo.gsfc.nasa.gov/epo/educators/dayatgoddard.php>

AstroZone: <http://www.imascientist.org/astrozone>

Cosmicopia: <http://cosmicopia.gsfc.nasa.gov>

Family Science Night: <http://sdo.gsfc.nasa.gov/epo/families/fsn.php>

SpaceMath@NASA: <http://spacemath.gsfc.nasa.gov>

Space Weather Action Center: <http://sunearthday.nasa.gov/swac>

Space Weather Media Viewer: <http://sunearthday.gsfc.nasa.gov/spaceweather>

Sun-Earth Day: <http://sunearthday.nasa.gov>

Think Scientifically: <http://sdo.gsfc.nasa.gov/epo/educators/thinkscientifically.php>

The E/PO Team

The HSD E/PO Team



Holly Gilbert
HSD Associate Director for Science, manages HSD E/PO activities, including collaborative efforts with the Public Affairs and Education Offices.



Beth Barbier
ACE E/PO Lead, Extraordinary Matter website PI, 14 years experience with HSD and ASD projects, proposals, program/product review, and facilitating communication between and within Divisions.



Troy Cline
Educational Technology Coordinator, 11 years experience developing programs that include cross-cultural education, podcasting, graphic and product design, social networking, and public speaking.



Emilie Drobnes
SDO E/PO Lead,
9 years leading development of award-winning programs that change perceptions of science and infuse in the public a better understanding of our closest star.



Steele Hill
SOHO and STEREO E/PO Lead, SDO Media Specialist, for 15 years has responded to media requests, created videos, and produced E/PO products to get solar mission imagery to the public.



Elaine Lewis
21 years teaching experience and a Masters degree in Curriculum Development. Elaine uses these skills for the formal education community who participate in SED and SWAC.



Aleya van Doren
SDO Formal Education Lead
After teaching middle school science, Aleya joined the SDO team in 2008 to create the formal education programs and resources for the mission.



Martha Wawro
SDO E/PO Deputy Lead
New to NASA and HSD, Martha brings her background in Project/Change Management and Informal Education to the day-to-day operations of the SDO E/PO team.



Lou Mayo
NASA Afterschool Astronomy Clubs PI, planetary scientist, and Marymount University professor of astronomy, with over 21 years experience leading NASA education programs.



Carolyn Ng
11 years experience working with HSD E/PO leads, coordinating many activities and resources for Sun-Earth Day, especially for informal and minority outreach.



Sten Odenwald
E/PO lead for Hinode and SpaceMath@NASA, developing new math problems for middle and high school students featuring NASA missions and their discoveries.



Andrew Wolt
SDO E/PO Logistics Coordinator, integral part of the team handling details that make programs like Family Science Night, Day at Goddard, and Exploration Station run smoothly.

Science Information Systems

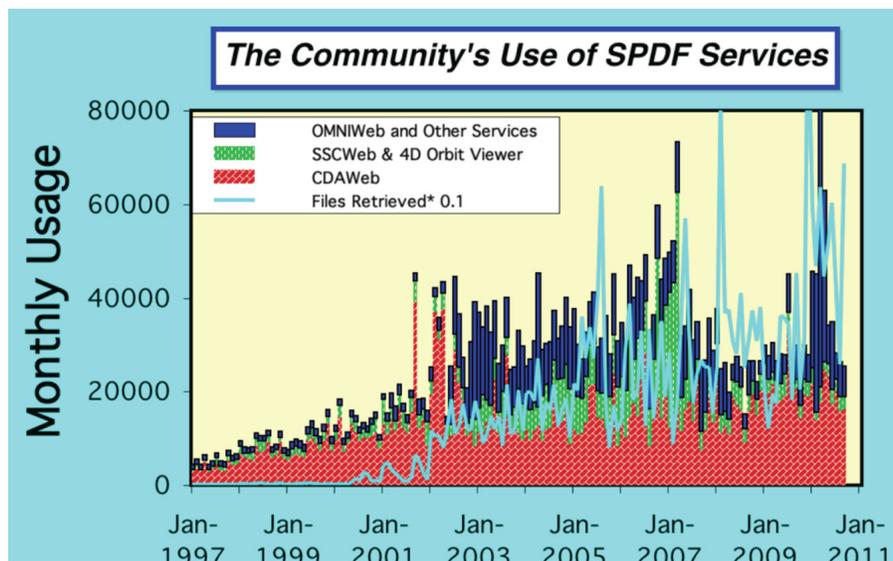
Science information systems in the HSD range from active final archives supporting data from large numbers of missions to single instrument science data production efforts. These systems are all critical to the scientific success of NASA heliophysics missions and provide for the widest possible dissemination of fully described mission data sets to the international science community. In addition, HSD staff often advise NASA HQ in the formulation of standards and heliophysics information architecture, e.g., development of the new NASA Heliophysics Science Data Management Policy (HSDMP, see <http://hpde.gsfc.nasa.gov>).

Final Archives

The HSDMP established two active Final Archives, both in HSD, that are responsible for preserving and ensuring long-term online availability and usability of data products from missions often past their primary science phase while providing support to the community for the proper use of the data.

Space Physics Data Facility (SPDF, R. McGuire Project Scientist). The SPDF has been designated as the active final archive for all non-solar heliophysics mission data. It consists of web-based services for survey and high-resolution data (e.g., the popular CDAWeb at <http://cdaweb.gsfc.nasa.gov>) and spacecraft trajectories (through SSCWeb at <http://sscweb.gsfc.nasa.gov>). The Facility supports data from most nonsolar NASA heliophysics missions to promote correlative and collaborative research across discipline and mission boundaries and is heavily used (see figure below).

SPDF also maintains the Common Data Format (CDF) software, which is increasingly a standard self-describing data format for nonsolar heliophysics data products. In addition, SPDF supports the Virtual Space Physics Observatory interface, which is an effort to tie the current data archives with the newly developing Virtual Observatories described below.



Solar Data Analysis Center (SDAC, J. Gurman, Facility Scientist). SDAC is the active final archive for NASA heliophysics solar data products (<http://umbra.nascom.nasa.gov>). SDAC supports SOHO, solar instruments on STEREO, and data from TRACE, Hinode, and a number of other missions.

The Heliophysics Data and Modeling Consortium (HDMC)

The newest part of the heliophysics data environment is the HDMC, which is responsible for organizing aspects of the data environment that do not fit into the conventional data center mold. These include Resident Archives for continuing the serving of data after missions end and before final archiving, Data Upgrades for making older data more useful, and Virtual discipline Observatories (VxOs) for providing uniform access to, common and detailed documentation of, and advanced services for data from the various HP sub-disciplines. The Project Scientist for the HDMC is D. A. Roberts of Code 672; he is responsible for the integration of the various efforts, as well as for logistics of running a group with projects located across the country. The HSD is the home for many of the newly developed Virtual Observatories:

- Virtual Solar Observatory (VSO) – J. Gurman (PI)
- Virtual Heliospheric Observatory (VHO) – A. Szabo (PI)
- Virtual Magnetospheric Observatory (VMO/G) – J. Merka (PI)

It also houses more focused, special interest VxOs such as

- Virtual Energetic Particles Observatory (VEPO) – J. Cooper (PI)
- Virtual Wave Observatory – S. Fung (PI)
- Heliospheric Event List Manager (HELM) – R. Candey (PI)

and involvement in other VxO efforts. While these VxOs are still being developed, they are already active and serving hundreds of commonly used heliophysics data products. The VxOs offer significantly expanded and uniform descriptions, accessible through a query interface that allows simultaneous complicated searches over multiple data sets. Development activities also include seamlessly connecting the various VxOs and incorporating event lists into the data query process.

Mission and Instrument Data Facilities

A core science information system activity in HSD is processing science data from individual mission and instrument telemetry into science quality data. HSD is the home for the STEREO Science Center (SSC) and for the Wind-Geotail ground data systems. These produce instrument level zero files, archiving spacecraft housekeeping and orbit/attitude information, and monitoring real-time observations and commanding. HSD also provides critical support for the SDO distributed science archive and distribution system.

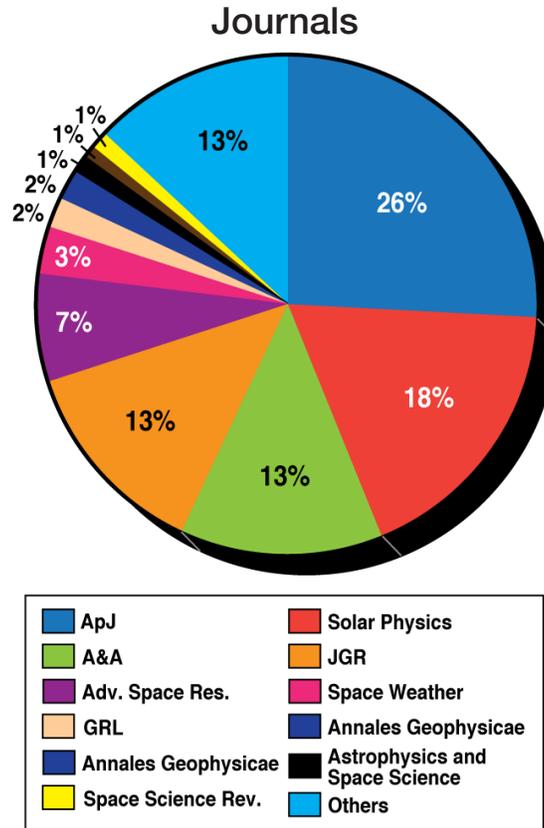
Individual science teams then process science quality data products. HPD is home for the Voyager magnetometer (MAG) and cosmic ray experiment (CRS) data production along with the Wind magnetometer (MFI), Wind and STEREO radio and plasma waves experiments and C/NOFS-CINDI data production.

The CDAW Data Center

The CDAW Data Center is a repository of information on coronal mass ejections (CMEs) observed by SOHO along with details on the associated phenomena such as flares, EUV transients, solar energetic particle (SEP) events, and geomagnetic storms. The main feature of the CDAW Data Center is the on-line catalog of all CMEs detected manually in the Large Angle and Spectrometric Coronagraph (LASCO) images. The CME attributes have been measured, and the characteristics are listed in the SOHO/LASCO CME catalog. Composite plots containing SEP intensity and Dst index along with CME height-time plots and GOES soft X-ray flux with the heliographic coordinates of the flares enable solar-terrestrial research. CME movies with Wind/WAVES dynamic spectra and GOES X-ray

flares help identify CMEs associated with flares and type II radio bursts. These data products have been extensively used by the Space Weather and Living with a Star (LWS) communities because disparate data sets are pieced together in a format easily usable by non-specialists.

The extensive community use is evidenced by the number of publications that explicitly acknowledge



Distribution of publications among major journals.

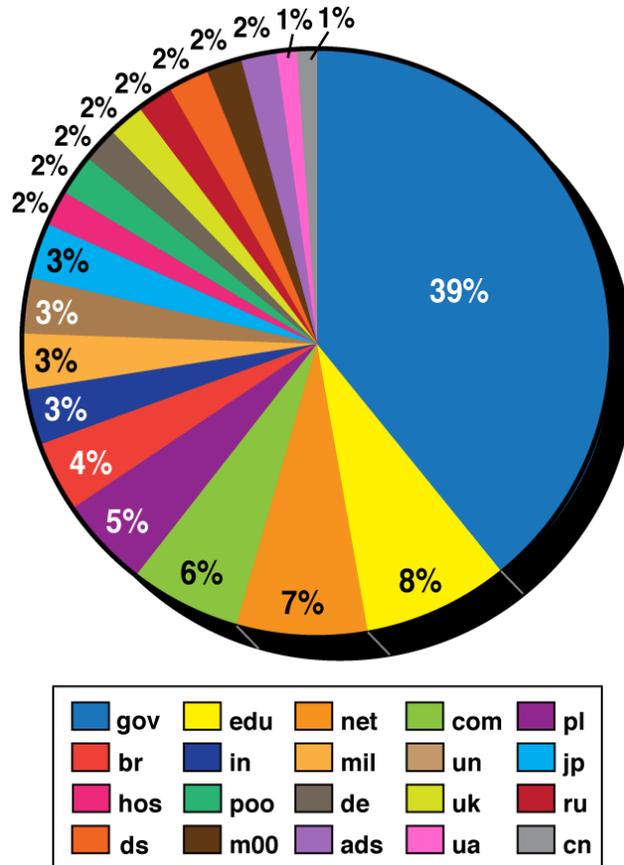
the data usage from the catalog. Figure above shows that nearly 700 papers have been published in the refereed journals since 2002, with an astonishing rate of 75 papers per year.

These papers are listed at: http://cdaw.gsfc.nasa.gov/publications/catalog_papers.htm. The refereed publications appeared mostly (70%) in the following journals: Astrophysical Journal (26%), Solar Physics (18%), The Journal of Geophysical Research (13%) and Astronomy and Astrophysics (13%). These journals are heavily used by the LWS and Space Weather communities. Thus the CME data products made available at the CDAW Data Center have been highly effective in enabling scientific activity in the United States and abroad.

The CDAW Data Center also contains many concise catalogs tailored to special populations of CMEs that result in significant disturbances in the heliosphere.

1. The Halo CME catalog lists all full halo CMEs detected by LASCO. There are nearly 500 halo CMEs in this catalog with measurements, plots, and movies similar to the main CME catalog.
2. The Wind/WAVES type II burst catalog contains all the CMEs that produced a type II radio burst observed by the Wind spacecraft. These are CMEs driving shocks near the Sun. Future plans include creating catalogs of SEP-producing CMEs and geoeffective CMEs.

Top 20 Domains



Top 20 domains that accessed the CME catalog for the month of 2010 September. The most frequent access to the CDAW Data Center is from U.S. Government domains followed by .edu, .net, and .com.

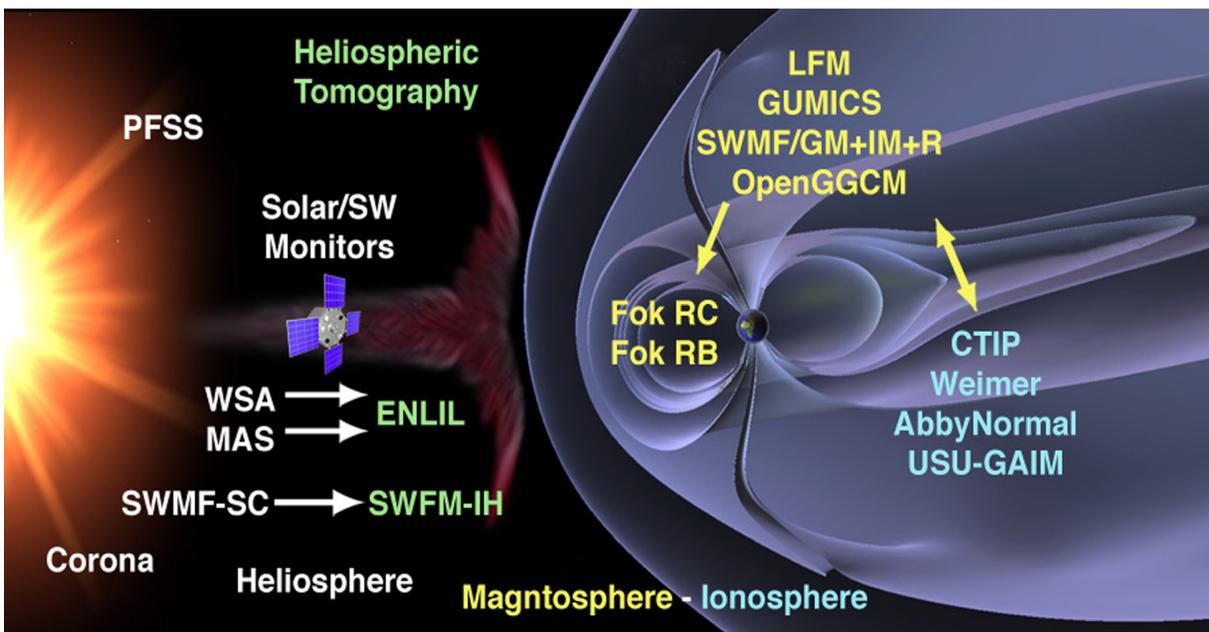
JavaScript-driven movies featuring various combinations of STEREO images are also routinely produced and made available online at the CDAW Data Center. The CDAW Center also contains data that formed the basis of many Coordinated Data Analysis Workshops since 1999. These data have been checked by a large number of people and hence are useful to young researchers. The plots, movies, and images available at the CDAW Data Center are heavily used by educators and teachers and by scientists for presentations because they are “ppt” ready.

The core team that run the CDAW Data Center are Nat Gopalswamy (671, Team lead), S. Yashiro (671), G. Michalek (Jagillonian University, Poland), P. Mäkelä (671), and A. Vourlidas (NRL). The work was supported in the past by the Air Force Office of Scientific Research (AFOSR), the National Science Foundation (NSF), and NASA. Currently the support is from NASA and Jagillonian University in Poland.

Community Coordinated Modeling Center

The Community Coordinated Modeling Center (CCMC) is a U.S.interagency activity aimed at research in support of the generation of advanced space science and space weather models. The CCMC consortium consists of NASA, NSF, the U.S.Air Force (USAF) Weather Agency, Directorate of Weather, Space and Missiles System Center, the Air Force Research Laboratory, the Air Force Office of Scientific Research, the Office of Naval Research, and NOAA. CCMC’s central facility is located at GSFC. The CCMC is supported primarily by NASA and by NSF. At present, CCMC staff are 11 FTE strong, consisting of space and computer scientists and information technology professionals.

The first function of the CCMC is to provide a mechanism by which research models can be validated, tested, and improved for eventual use in space weather forecasting, such as needed for NASA’s Vision for Space Exploration. Models that have completed their development and passed metrics-based evaluations and science-based validations are being handed off to the forecasting centers at NOAA and the U.S.Air Force for space weather applications. In this function, CCMC acts as an unbiased evaluator that bridges the gap between space science research and space weather applications.



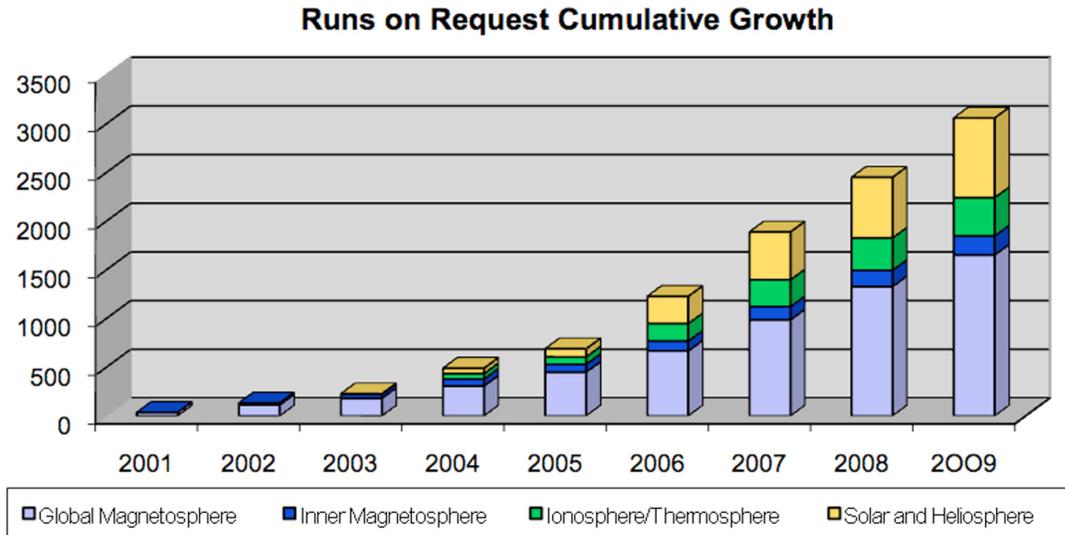
Overview of models at the CCMC

As a second, equally important function, the CCMC provides to space science researchers all over the world the use of space science models, even if they are not model owners themselves. This service to the research community is implemented through the execution of model “runs-on-request” for specific events of interest to space science researchers at no cost to the requestor. Model output is made available to the science customer by means of tailored analysis tools and data dissemination in standard formats. Through this activity and the concurrent development of advanced visualization tools, CCMC provides to the general science community unprecedented access to a large number of state-of-the-art research models. The continuously expanding model set includes models in all scientific domains from the solar corona to Earth’s upper atmosphere.

Science Support

CCMC science services are provided through Web access (<http://ccmc.gsfc.nasa.gov>). Here, users can request calculations from more than 25 modern space science models, which are hosted at the CCMC through very positive collaborations with their owners.

After a run request, a user will be notified via e-mail once the calculation is complete. At this time, the run can be analyzed via tailored visualization tools, again via Web access. These tools have been continuously refined for more than 10 years, primarily in response to user requests. Recently added capabilities include Poynting flux calculations, model outputs, field-line tracing along satellite trajectories, movie generation, and time line, and topology capabilities.



Cumulative Run-on-Request (RoR) growth through 2009. The utilization of CCMC RoR services continues to grow rapidly.

CCMC-run analysis services are also used heavily. In 2009, an average month saw about 4,000 visitors, and nearly 20,000 visits, and similar statistics apply to 2010. Visualization requests typically lead to the creation of tens of thousands of visualization pages each month. These monthly averages continue to increase from year to year.

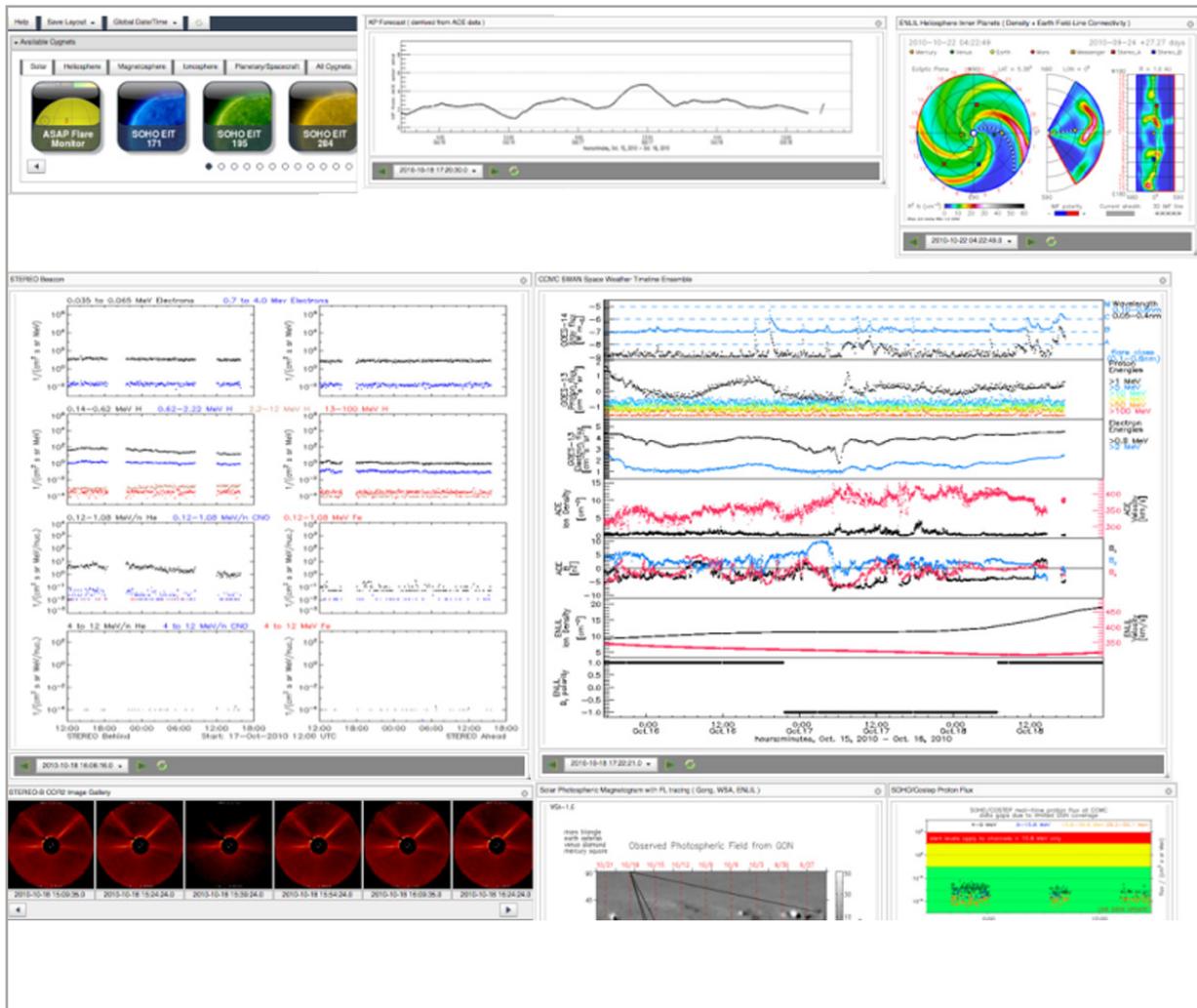
Furthermore, the CCMC staff is continuing to develop new means to support users in their scientific studies. In the realm of visualization, OpenDx- and JAVA-based visualization with enhanced 3D capabilities is now available for a number of different model outputs. With both OpenDx- and IDL-based 3D visualizations, users can request output in Virtual Reality Modeling Language (VRML) form, which permits real-time in-depth analysis of complex 3D structures.

Further science services at the CCMC include the provision of the Model Web, where a large set of empirical or analytical models, such as the International Reference Ionosphere (IRI), are available for interested users for download or execution. CCMC is also supporting space science missions, for example STEREO, THEMIS, and MMS. Science mission support includes background science information derived from routine runs, or calculations in support of specific campaigns or specific science objectives.

As in the past, the future of CCMC services will be shaped by the needs of the science community. Community input is solicited formally and informally, through meetings, tailored workshops, and personal contacts.

Space Weather Modeling and Forecasting

The second focus of CCMC is related to the need to bring modern space science modeling to bear on the needs of space weather forecasting. NASA as well as forecasting agencies need models of proven forecasting abilities. Operational models must be robust, have accuracies that are well understood, and be packaged in a way that makes them easy to integrate into existing computational environments. The operational models must also be capable of executing reliably in real time. With these objectives, the CCMC tests models for accuracy, robustness, performance, and portability. Model accuracy is tested in two ways: through metric studies and through scientific validation studies. As a result, the CCMC can characterize the usefulness of these models for the forecasting role to which they would be applied. By testing how the models behave with a wide range of inputs, the CCMC can establish regimes in which the models appear robust and can identify regimes that cause the models to fail. Through exposure to a range of compilers and hardware platforms, the CCMC improves the portability of these models. Finally, by measuring computational performance, the CCMC establishes the conditions needed for each model simulation to complete in real time or better.



Sample space weather layout from iSWA site.

Performing these types of analyses on models in a protected academic environment might produce less robust results. It is imperative that these models undergo tests in an environment that stresses them in the same fashion as will occur at the operational agencies. Accordingly, the CCMC challenges all models by utilizing them in a quasi-operational setting, namely the Runs-on-Request facility, as well as through a real-time simulation system. For the latter purpose, CCMC has established various real-time execution systems, starting with solar and solar wind modeling of photospheric magnetograms, and magnetospheric calculations driven by ACE data. The establishment of these systems has led to a wealth of expertise in the design and maintenance of real-time modeling. In collaboration with model owners, CCMC has supported the creation of robust models of scientific and space weather utility.

Already for several years, products from model runs at the CCMC have been combined with measurements from NASA and other missions to provide NASA mission operators with space weather information. Beginning with a NASA robotic mission operator workshop in 2009, and culminating with the formal establishment of the Space Weather Desk within the Space Weather Laboratory, this service has been expanded to provide regular space weather updates as well as alerts to robotic mission operators across the agency. This activity is supported by the integrated Space Weather Analysis (iSWA) system (<http://iswa.gsfc.nasa.gov>), an innovative dissemination system developed with support from NASA's office of Chief Engineer and from GSFC. Space weather services continue to be shaped by customer input – most recently through the second robotic mission operator workshop. This activity not only provides direct and tangible support to NASA's robotic missions, but also serves to showcase the value of space weather research and development in heliophysics to the broad NASA community.

Owing to the diversity of space weather-relevant information sources, space weather analysis and forecasting will, in the future, increasingly rely on access to distributed information providers. The iSWA site is an important step in this direction of information collection. While it addresses NASA's needs primarily, this information can also support governmental as well as commercial space weather interests. CCMC therefore has ongoing close collaborations with the USAF, with NOAA, and with both international space weather interests and commercial enterprises in the US. An example of the latter is a partnership with the Electrical Power Research Institute (EPRI), which led to the generation of a state-of-the-art forecasting system for geomagnetically induced currents (GICs) in the North American power grid.

More information about the CCMC may be found at the CCMC website <http://ccmc.gsfc.nasa.gov>. Information about space weather services may be found at the Space Weather laboratory site <http://swl.gsfc.nasa.gov>.

Technology Development

GSFC and NASA support new technology in HSD through three programs. The main source of support at GSFC is the GSFC Internal Research and Development (IRAD) program, which funds the development of new technology to support proposals to be submitted in response to future announcements of opportunity. The Technical Equipment program provides funding for purchases of advanced technology equipment and replacement of outdated equipment needed to support the development of new instrumentation. The Small Business Innovative Research (SBIR) program provides funding to develop new flight hardware and software concepts in the commercial sector in support of future flight opportunities. The technology development activities within the Heliophysics Science Division are led by Dr. John Sigwarth, Senior Scientist for Technology Advancement, with support from Dr. George Khazanov.

The IRAD program of GSFC runs on an annual basis for each fiscal year. An announcement of opportunity is released in early June describing the requirements of the opportunity for the subsequent fiscal year. Step 1 proposals are submitted in late June. A heliophysics proposal review panel including the Heliophysics Line of Business Committee and the Senior Scientist for Technology Advancement meets in July to rank the proposals and recommend to the Center-wide integration panel those proposals that should progress to the second phase. Step 2 proposals are submitted in late July. The review panel meets again in early August to rank the Step 2 proposals and recommend funding to the Center-wide integration panel. Funding approval by the Center-wide integration panel is contingent on the available resources and the relative ranking of HSD proposals with respect to other focus areas within GSFC. In FY2010, a total of 18 Step-1 proposals were submitted resulting in 11 projects funded by the GSFC IRAD program. For these winning projects, the FY2010 IRAD program funded a total of 13.2 FTEs and an additional \$557.7 K for procurements in support of the selected IRAD proposals. In FY2011, a total of 27 Step 1 proposals were submitted resulting in 14 projects funded by the GSFC IRAD program. For these winning projects, the FY2011 IRAD program funded a total of 12.7 FTEs and an additional \$524 K for procurements in support of the selected IRAD proposals.

The new technologies supported by the GSFC IRAD program cover a broad range of heliophysics topics. These technologies include innovative approaches to high-resolution solar imaging, radiation-tolerant ion mass spectrometers, high-efficiency X-ray diffractive optics for solar flare observations, ion-neutral wind and composition suites for upper atmospheric measurements, radiation-hardened extreme environment ASICs, deployable radial imaging for velocity electric field and plasma density, a focal-plane polarizer for solar and heliospheric imaging, evaluation of new microchannel plate technologies, ultrathin windows for silicon solid-state detector telescopes.

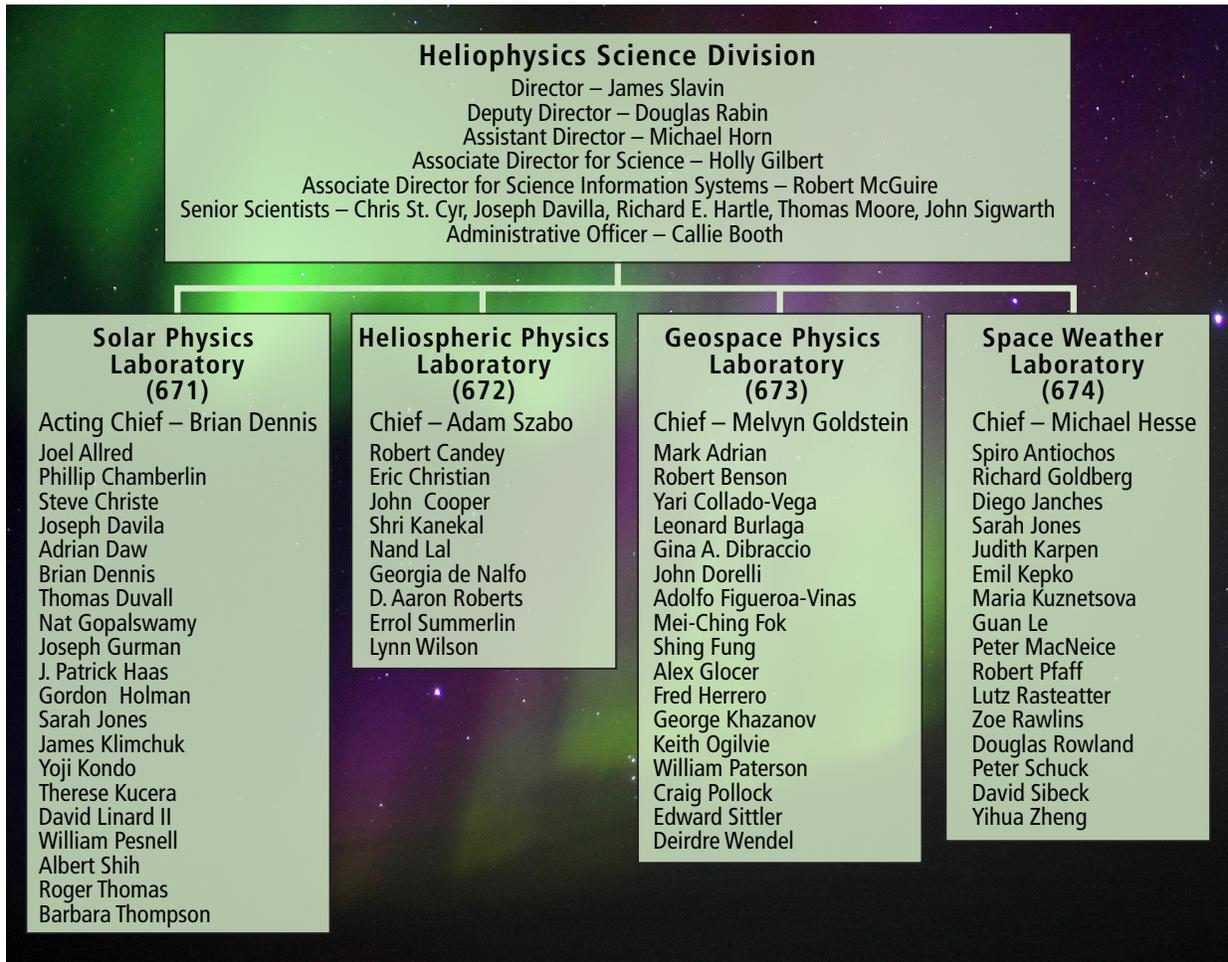
The GSFC Technical Equipment program is run on an annual fiscal year basis to purchase new capital equipment or replace obsolete equipment. Each year suggestions for equipment purchases are solicited in May from HSD members. These requests are ranked by the HSD management and brought forward to the Science and Exploration Directorate. In FY2010, approximately \$231K was allocated for technical equipment purchases within HSD. In FY2010, the technical equipment fund within the HSD was oversubscribed by 150%. In FY2011, approximately \$248.7K is allocated for technical equipment purchases within HSD. In FY2011, the technical equipment fund within the HSD was oversubscribed by 480%.

The SBIR program within NASA provides an opportunity for small, high-technology companies to participate in government-sponsored research and development (R&D) efforts in key technology areas. The SBIR program provides up to \$100 K for phase 1 studies that last approximately 6 months. If the project is granted a phase 2 award, the SBIR program funds up to an additional \$750K. In

February, new technology needs for HSD are identified by members within the division and vetted by GSFC- and NASA-wide integration panels. Solicitations based on the identified key technology areas are released annually. Selected SBIR companies work with the oversight of the Contracting Officer's Technical Representative to achieve the desired technology goals. For FY2010, two SBIR proposals were selected in the area of heliophysics for phase 1 studies into miniature laser magnetometers and elastic deployable composite tubular roll-out booms. Recently, both of these SBIR projects have received approval to proceed into phase 2.

APPENDIX A: Individual Scientific Research

The following section contains short summaries of the research being performed by scientists in HSD. The organization is divided up into four groups, or laboratories, with the civil servant complement shown in the detailed organization chart shown below.



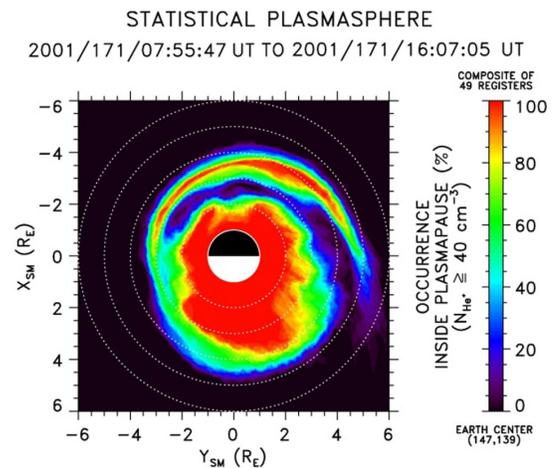
Mark L. Adrian



Dr Adrian is a thermospheric-ionospheric-magnetospheric physicist who joined the Geospace Physics Laboratory Code 673 in November 2004. He serves as Deputy Project Scientist on the Magnetospheric Multiscale (MMS) satellite constellation mission and is the Instrument Scientist for the Dual Electron Spectrometer (DES) component of the MMS Fast Plasma Investigation (FPI). Mark received his BS (1989) and MS (1993) degrees in physics from the University of Iowa and was awarded a PhD from the *University of Alabama, Huntsville*, in 2000.

Dr Adrian supports ongoing research efforts in collaboration with NASA's Marshall Space Flight Center (MSFC), University of Arizona, University of Iowa and Southwest Research Institute. Additionally, during FY2010 he served on several NASA and NSF peer review panels. Locally, Dr Adrian serves in dual roles for the Small Business Innovative Research (SBIR) program, both as a Deputy Subtopic Manager for Subtopic S1.12: Lunar Science Instruments and Technology and as a proposal reviewer.

In addition to his responsibilities on MMS, Dr Adrian continues to pursue a varied program of advancing both the development of novel plasma diagnostic instrumentation and basic research that reaches from the thermosphere through the solar wind to the furthest extent of the heliosphere. During FY2010, Dr Adrian continued to lead an IRAD effort to prototype the Electron Concentration versus Height from an Orbiting Electromagnetic Sounder (ECHOES) effort: a simple, low-resource, space-based radio-sounding experiment designed to gather measurements of the altitude profile of electron density (N_e) for implementation on future heliophysics missions. In addition, he initiated an effort at GSFC to implement and advance a miniaturized electron spectrometer originally developed at MSFC. The Goddard Thermal Electron Capped Hemisphere Spectrometer, or G-TECHS, is a miniature spectrometer designed specifically to measure the electron distribution of planetary atmospheres. Dr Adrian also conducts research into inner-magnetospheric coupling to understand the dynamical processes that generate and circulate plasma through Earth's plasmasphere.



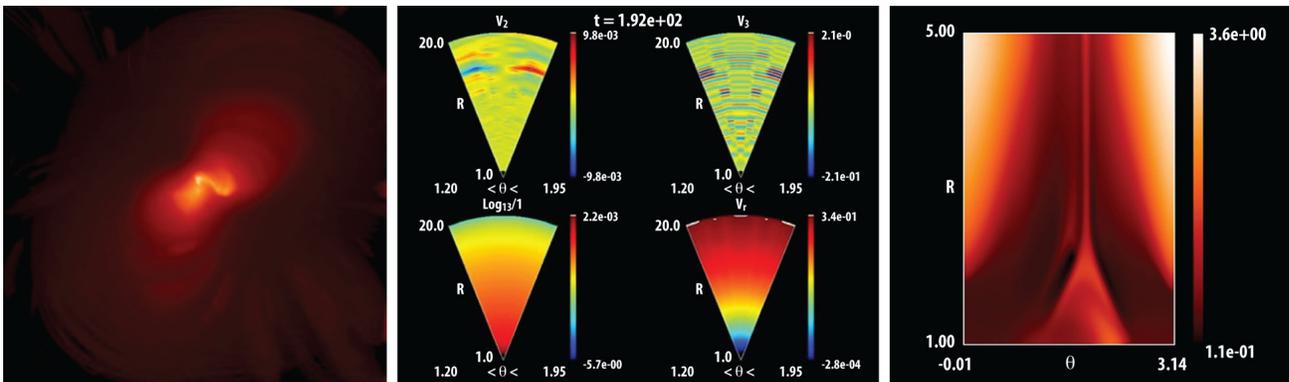
A statistical map of the occurrence and distribution of plasmaspheric He⁺ during the recovery phase of a geomagnetic storm. Clearly illustrated through the nightside sector of the data is the presence of a low-probability region associated with the formation and evolution of an embedded plasmaspheric trough.

Vladimir Airapetian



Dr Airapetian was born in the city of Baku, Azerbaijan. He obtained his BS and MS degrees in astronomy from Yerevan State University, Armenia, and a PhD in astrophysics from Byurakan Astrophysical Observatory in 1990. He worked at Byurakan Observatory until 1994, and then as a post-doctoral research scientist at the National Solar Observatory and Los Alamos National Laboratory, NM. Since 1995, Vladimir has been an astrophysicist at GSFC (currently in Code 671) and a Research Associate Professor at George Mason University. He has a broad range of interests including the physics of the solar coronal

heating, magnetohydrodynamics (MHD) of coronal streamers, and MHD models of stellar winds from late-type evolved stars.



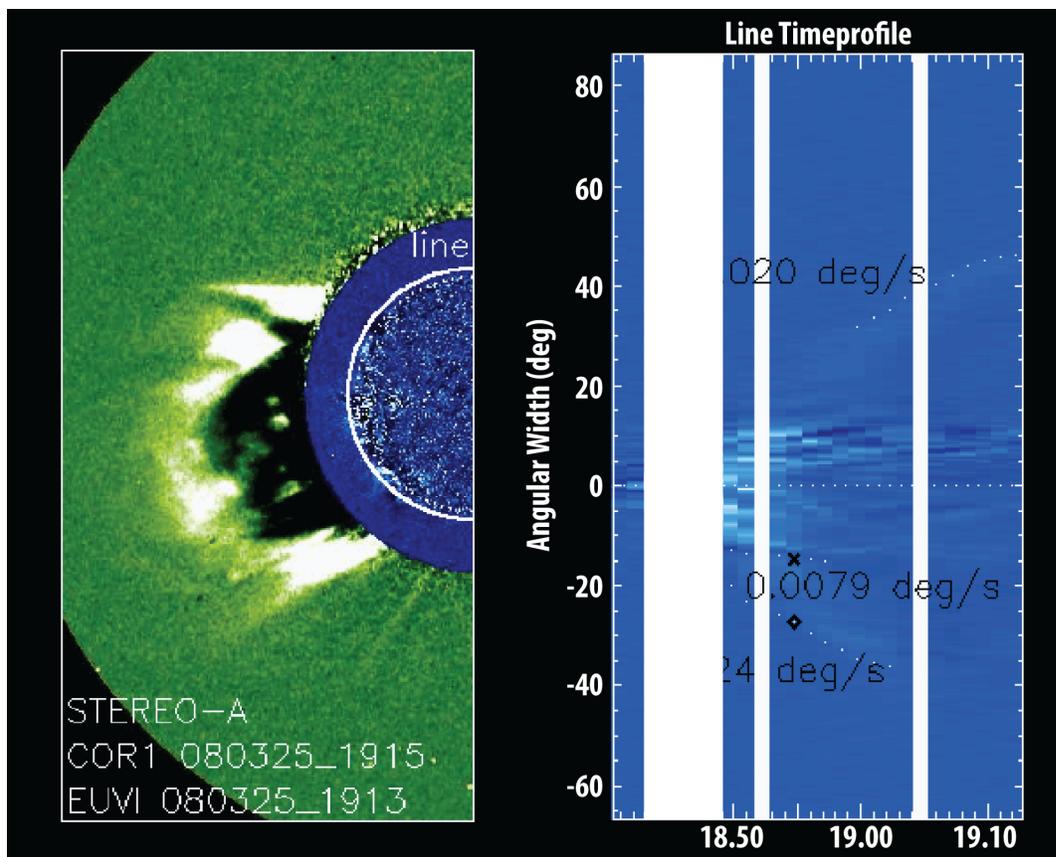
This past year, Dr Airapetian has been actively working in four major directions. First, he has developed a model that calculated the three-dimensional synthetic images of solar coronal loops obtained by extrapolating an observed photospheric magnetogram into the corona and nanoflare-driven impulsive heating. By determining which set of nanoflare parameters best reproduces actual observations, he hopes to constrain the properties of the heating and ultimately reveal the physical mechanism. Second, Dr Airapetian has performed semi-empirical, time-dependent, fully non-linear MHD simulations of an equatorially confined streamer belt by using observational constraints in a single-fluid 2.5D MHD modeling. Specifically, he reproduced the COR1 STEREO observations of an equatorially confined streamer obtained on 2008 February 1 through 14 using the PFSS model of the initial coronal magnetic field configuration with the boundary conditions at the photosphere. Third, he has developed a 2.5D hydrodynamic model of winds from cool, evolved stars and derived a scaling law for mass loss rates from giant and supergiant stars. Fourth, Dr Airapetian has begun to study the evolution of the electron distribution function in the solar corona and the solar wind by using a modified version of the existing Fokker-Planck code.

Sachiko Akiyama



Sachiko was born in Saitama, Japan. She received her BEng (1996) and MEng (1998) degrees in aeronautics and astronautics from Tokai University, and her PhD in astronomical science from the Graduate University for Advanced Studies, Tokyo in 2001. She studied the high-temperature region above flare loops observed by Yohkoh/SXT for her PhD. She worked at the Hida Observatory of Kyoto University and at the George Mason University. She has been with the Catholic University of America since 2004.

In 2010, Sachiko mainly worked on the identification of solar sources of interplanetary shocks for a study that compared the radio emission characteristics of the shocks (Gopalswamy et al. 2010). Currently, Sachiko is working with Dr Gopalswamy on the shock wave signatures of coronal mass ejections (CMEs) observed by STEREO/EUVI and COR1. They are studying the evolution of the height and angular width of the CME and the EUV wave front (shock) associated with the M1.7 flare (see figure Below).



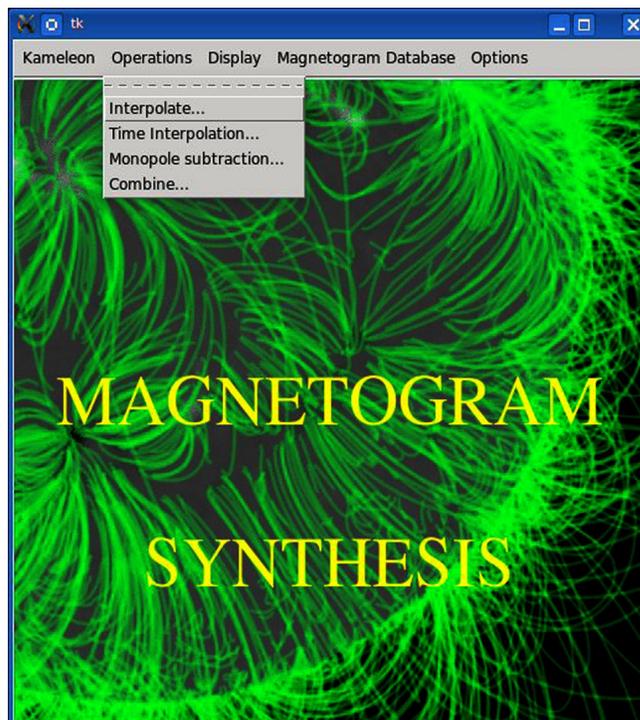
The shocks wave and the expanding flare loops observed with STEREO/EUVI on 2008 March 25. The diamond symbol indicates the shocks and the cross symbol indicates loops.

Joel C. Allred

Dr Allred is a solar astrophysicist in the Solar Physics Laboratory (671). He received his PhD from the University of Washington in 2005 and spent one year as a post-doctoral scientist at GSFC. He left GSFC to take a position at Drexel University where he became a research assistant professor. In September 2010, he returned to GSFC and rejoined the Heliophysics Science Division.

Dr Allred has worked on producing models of solar flares and coronal mass ejections (CMEs). His flare models involve simulating the response of the chromosphere to electron beam flare heating. The models include optically thick non-LTE radiation hydrodynamics allowing the calculation of detailed atomic line profiles which can be compared with observations. He has also added a model solar wind to a 2.5D MHD code and used it to model the evolution of breakout CMEs in the solar wind.

Dr Allred is also involved in a project headed by Dr Peter MacNeice to model the slow evolution of global coronal magnetic fields. Dr Allred is developing a database of available magnetograms and a tool that can interpolate, process and combine them. Magnetograms processed by this tool will be used as boundary constraints on the models produced by Dr MacNeice. This tool has been named MAGIC (MAGnetogram Interpolation and Composition) and will be made available to the solar physics community.



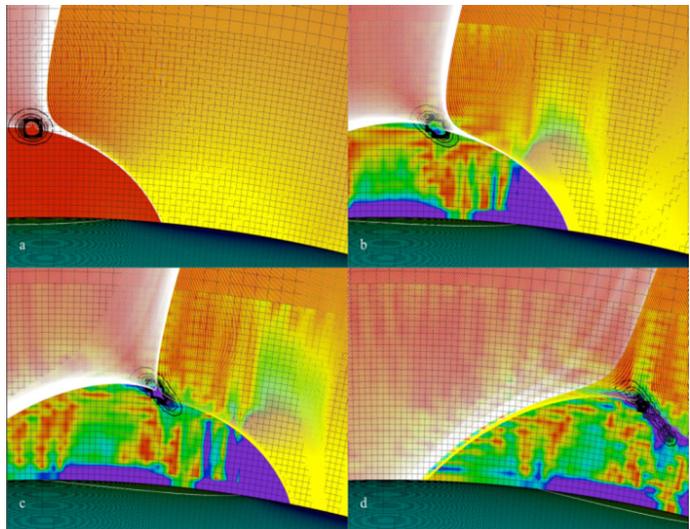
Spiro K Antiochos



Dr Antiochos joined GSFC in January 2008 as a research astrophysicist in the Space Weather Laboratory. He is also serving as an adjunct professor in the Department of Atmospheric, Oceanic, and Space Sciences at the University of Michigan, where he has been the Research Supervisor for two PhD students and is currently supervising two more PhD students. He obtained his PhD at Stanford University in applied physics. Dr Antiochos was awarded the NASA Outstanding Leadership Award in 2010. Dr Antiochos is Vice-Chair of the Solar and Heliospheric Physics Panel of the 2012 Solar and Space Physics Decadal Survey by the National Academies. He is Principal Investigator (PI) of a Heliophysics Theory Program and PI and Team Leader for the LWS Targeted Research and Technology Team focused on Integrating Kinetic Effects into Global Models. Dr Antiochos is a co-investigator (Co-I) on the SPICE instrument on the Solar Orbiter Mission.

Dr Antiochos' research consists of developing theoretical models for major solar/heliospheric activity such as CMEs and flares, and then testing and refining the models with numerical simulations and comparison with data. He is one of the pioneers of computational solar physics. Last year he worked on extending his breakout model for coronal mass ejections, his thermal non-equilibrium model for the formation of prominence/filaments, his S-web model for the solar sources of the slow solar wind, and his helicity condensation model for the origin of filament channels and slow wind turbulence.

Dr Antiochos also worked on the basic physics of magnetic reconnection, perhaps, the most important process driving solar/heliospheric activity. This work led to five refereed publications in archival journals, nine presentations (seven invited), and three successful proposals.



Evolution of an embedded bipole moving from an open-field coronal hole into a closed-field region via interchange reconnection:

a) $t = 0$ s; initial configuration showing white open field lines, and orange closed. The black contour lines indicate the magnetic null point. b) $t = 5,880$ s; current sheet formation. The filled color contours indicate current magnitude.

c) $t = 7,480$ s; global topology change of external spine. d) $t = 10,000$ s; final configuration showing that the bipole is wholly inside the closed field.

S. Beth Barbier



Ms. Barbier has worked at GSFC for 19 years, 14 of those in Education and Public Outreach (EPO) for the Astrophysics Science Division (ASD) and the Heliophysics Science Division (HSD). She is currently the HSD E/PO Specialist, the ACE mission E/PO Lead, and PI for the “Extraordinary Matter” Web site (currently in development). She is also a member of the ASD E/PO team and represents the HSD in the GSFC Science Communications Working Group. She routinely facilitates communication between divisions.

Ms. Barbier directly supports and advises Dr Holly Gilbert and others in Division E/PO by improving communications and directing the team to good resources, including each other. She takes an active role in introducing scientists to E/PO leads and projects as opportunities arise. In the last year, she has facilitated funding, coordination, and activities in current and potential E/PO efforts, and led monthly HSD E/PO meetings. Along with Division E/PO specialists, these meetings are regularly attended by representatives from the GSFC Education and Public Affairs Offices and the HSD science writer, which has considerably improved communication, understanding, and focus among all involved. Within the Division, Ms. Barbier also facilitated the development of E/PO proposal ideas, and the proposals themselves, within the group. With many others in HSD, she supported the GSFC’s E/PO Open House in December and the GSFC Science Jamboree in June.



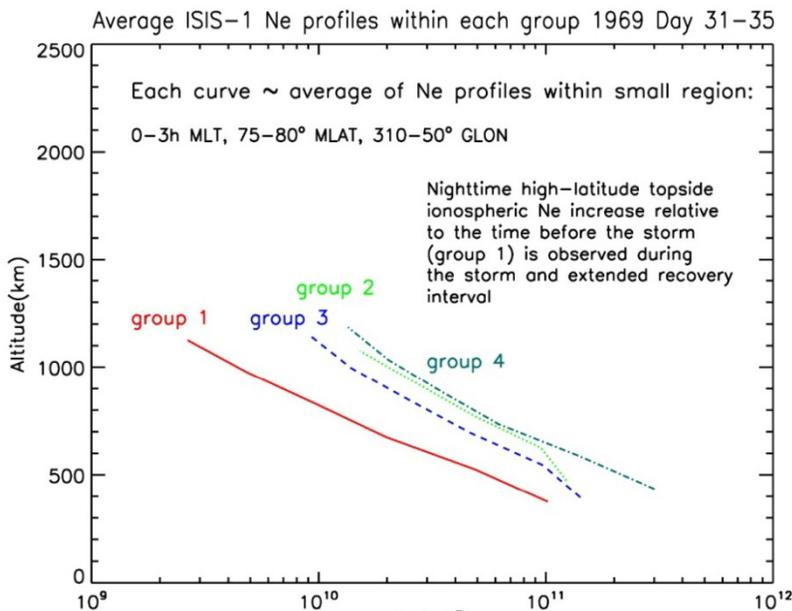
As the ACE E/PO Lead, Ms. Barbier’s primary responsibility was to maintain the Cosmicopia public outreach Web site, whose focus is on cosmic rays and heliospheric science. The high-school-level site also includes some astrophysics basics, related news stories, a glossary, a history of cosmic ray studies, and over 600 questions and answers from visitors to the site. It currently receives over a half million hits per month.

Robert F. Benson



Dr Benson was born in Minneapolis, Minnesota and has a BS degree in geophysics and MS degree in physics from the University of Minnesota (1956 and 1959) and a PhD in geophysics from the University of Alaska (1963). He was a scientific member of the first wintering-over party at the Amundsen-Scott IGY South Pole Station (1957), Assistant Professor in the Department of Astronomy at the University of Minnesota (1963/64), and has been with GSFC for 46 years (first as a NASA/NRC postdoctoral resident research associate, and then as a scientific civil servant since 1965).

During 2010, the GSFC ISIS data restoration and preservation effort, which produced digital topside ionograms, was completed under Dr Benson's direction. This data-preservation effort included data from the ionospheric topside-sounders on the Alouette-2, ISIS-1, and ISIS-2 satellites. More than a half-million digital ionograms were produced from a select subset of the original seven-track analog telemetry tapes recorded at 24 globally-distributed telemetry stations between 1965 and 1985. Since most of these tapes were never processed into 35-mm film ionograms, due to budget limitations, this project was equivalent to creating a new satellite mission with old data.



Enhanced Ne profiles observed during a large magnetic storm (maximum Dst \approx -190 nT during group 2) that persisted for at least two days (groups 3 and 4). The average Ne profiles prior to the magnetic storm are shown in group 1.

A current research goal is to establish links between variations in solar-wind parameters and variations in high-latitude topside-ionospheric electron-density (N_e) values during large magnetic storms. In one case investigated (see figure above) enhanced N_e profiles were attributed to an extended solar-wind velocity streamer.

Anand K. Bhatia



Dr Bhatia received his BS (with Honors) degree in 1953 and his MS degree in 1955 from University of Delhi, India. He received his PhD from the University of Maryland in 1963. After spending a few months at Wesleyan University, Dr Bhatia came to GSFC in 1963, where he still serves as a retired physicist.

While at GSFC, his research interests have spanned various topics in atomic physics, many of which are directly relevant for astrophysical measurements, including scattering of electrons and positrons from atoms, muonic fusion, polarizabilities of two-electron systems, Lamb shift, Rydberg states and excitation of ions. He is a Fellow of the American Physical Society.

Dr Bhatia has been working with Dr Enrico Landi (formerly at NRL, now at the University of Michigan) on calculations for a number of ions. They have recently calculated oscillator strengths, transition rates and collision strengths for the following ions: Al V, Ca IX, Fe XXIII and Ni X, XI, XVII. From these data, they calculate rate coefficients to be used in the statistical equilibrium equations to calculate intensities of spectral emission lines. These calculated data have been added to CHIANTI, an atomic physics database. These calculations have become a major research tool for the solar and astrophysical communities and are used to infer plasma parameters such as electron density, temperature and the abundance of various elements when analyzing observations of the Sun and other stars.

Dr Bhatia hosted Dr Chandana Sinha, a visiting scientist from the Indian Association for the Cultivation of Science, at GSFC for four days in July and then for the month of December, to collaborate on several problems in the laser field. They have written a paper, "Laser-assisted Free-free Transitions in Electron-atom Collision," which will soon be submitted to Physical Review A.

Dr Bhatia attended the 41st annual meeting of the American Physical Society's Division of Atomic, Molecular and Optical Physics (DAMOP), in Houston, Texas, during 2010 May 25 through 29 where he presented two posters, one with his visiting coauthor Dr Sinha and a second with HSD colleague, Dr Richard Drachman, also an emeritus physicist.

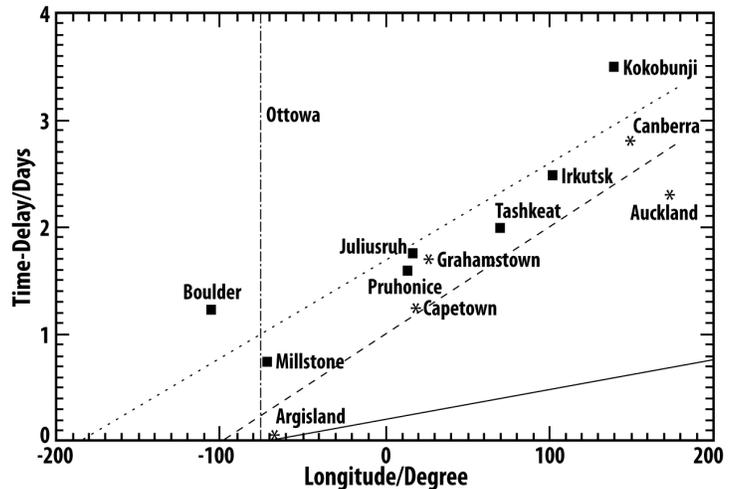
Dieter Bilitza



Dr Bilitza is an expert in ionospheric physics and the principal author of the International Reference Ionosphere (IRI), a widely-used standard for the ionosphere. He is a research professor at George Mason University and works on the SESDA contract in GSFC's Heliospheric Physics Laboratory. Dr Bilitza first came to GSFC as an atmosphere explorer guest investigator in 1979, and then returned in 1985 to work at the NSSDC and the Space Physics Data Facility. He received his Diploma and PhD in physics from the Albert-Ludwigs University in Freiburg, Germany.

Dr Bilitza is the Chief Support Scientist at the SPDF that maintains the CDAWeb, SSCWeb, and OMNIWeb services which are widely used in the science community. Besides working with active missions, he has also helped to save older data sets and make them user accessible (e.g., the unique Alouette/ISIS Satellite Program's topside sounder database). He is a member of the Virtual ITM Observatory (VITMO) team and developed the ModelWeb interface to empirical models that is now part of the CCMC. His science collaborations during the last year involved scientists from LaRC; NOAA NGDC; JHU/APL; Ohio State University; University of Colorado, Boulder; University of Massachusetts, Lowell; Hermanus Magnetic Observatory in South Africa; Institute of Atmospheric Physics in the Czech Republic and the German Geodetic Institute. The main goal of this collaboration is to improve the IRI model.

During the last year, one research focus was the correlation between the 27-day solar rotation period as seen in the F10.7 radio flux and in F-peak plasma frequency measurements from ionosondes. The ionospheric observations exhibit a 1- to 3-day time delay. The cause is most likely oxygen, which reaches lifetimes of several days in the F-region and is a major source for F-region ions and electrons. Studying the delay at several ionosonde stations, indicates a clear correlation with longitude as shown in the figure on the right. Because F10.7 is measured at Ottawa at 12:00 noon, a small longitudinal dependence is expected (solid curve at bottom), but it is much smaller than what is observed. Dr Bilitza will use theoretical models to study this further.



Scott Boardsen



Dr Boardsen is a scientist in the HSD. He has worked at GSFC since 1993. He received his PhD in physics from the University of Iowa in 1988, where he studied electrostatic-ion cyclotron waves.

He is a member of the MESSENGER science team, and works on science support, analysis and interpretation of magnetometer data taken by the MESSENGER spacecraft.

Dr Boardsen studies plasma waves, plasma structures, and their interaction with particles in planetary magnetospheres. His current research focus is on the analysis and interpretation of ultra-low frequency (ULF) waves and of Kelvin-Helmholtz waves detected at Mercury by the magnetometer flown on the MESSENGER spacecraft. He is studying the role these waves play in energy transfer within plasmas and as a diagnostic of magnetospheric processes and composition. He is also studying the interrelationship between Mercury's magnetosphere and heavy ions, mainly Na^+ , created by ionization of Mercury's exosphere.

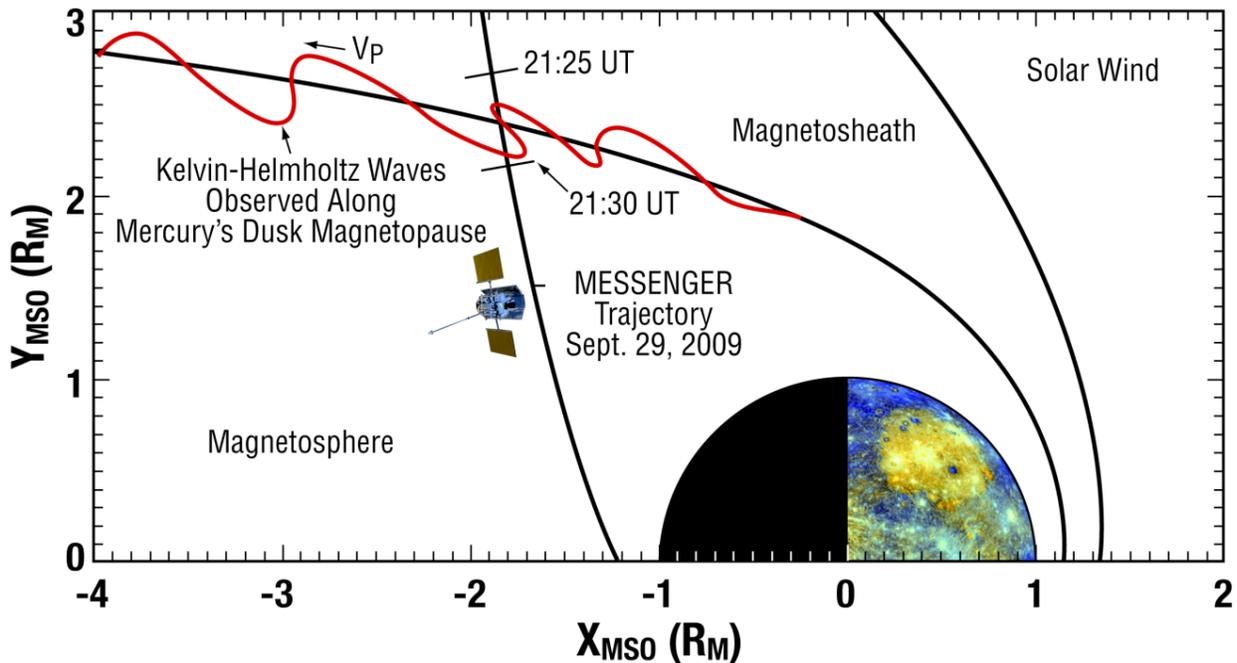


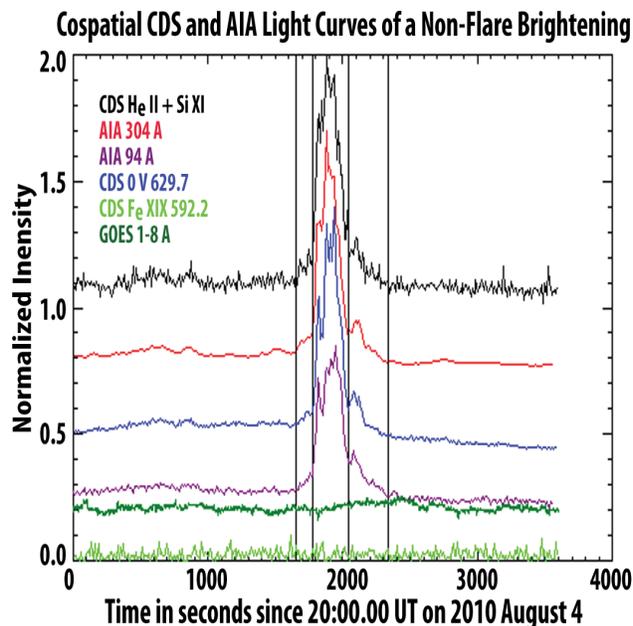
Illustration of Kelvin-Helmholtz waves observed along Mercury's magnetopause during the third Mercury flyby.

Jeffrey W. Brosius



Dr Brosius received his BA in physics from Franklin and Marshall College, Lancaster, PA, and his PhD in physics from the University of Delaware through the Bartol Research Institute, Newark, DE. He has been working in the Solar Physics Laboratory at GSFC since 1985, employed by The Catholic University of America since 2002.

Research during 2010 focused on flare dynamics based on rapid cadence (7.2 to 9.8s) EUV spectra from SOHO CDS and EUV images (at 12-s cadence) from SDO's AIA, as well as on quiescent Sun studies based on EUNIS-06 and EUNIS-07 spectra. In collaboration with T. Wang, D. M. Rabin, and R. J. Thomas, Dr Brosius developed and implemented a technique to calibrate the EUNIS-06 short-wavelength (170–205 Å) channel based on a combination of insensitive line intensity ratios, the laboratory-calibrated long wavelength channel (300–370 Å), and coordinated CDS spectra. A similar method was applied to derive the in-flight absolute calibration correction for Hinode EIS from coordinated, calibrated EUNIS-07 quiet Sun spectra. In collaboration with G. D. Holman, observations of a microflare with RHESSI and CDS revealed that the onset of the microflare was observed in upper chromospheric (He I) and transition region (O V) line emission before it was detected in high-temperature flare plasma emission. In intervals lasting up to 3 m during several bursts, the He I and O V profiles showed secondary, highly blueshifted (200 km/s) components. More recently, AIA images for selected events (like those coordinated with rapid cadence CDS stare spectra) have been obtained using the AIA “cutout service.” Light curves derived from AIA images at the location of the CDS slit during a non-flare brightening reveal that all seven of AIA's EUV channels show a marked enhancement during the event, even though RHESSI, GOES, and CDS (Fe XIX) show that the brightening did not produce 10-MK flare plasma emission. Preliminary studies of B- and M-class flares with AIA images confirm that emission from cool plasma brightens minutes before that from hot flare emission.



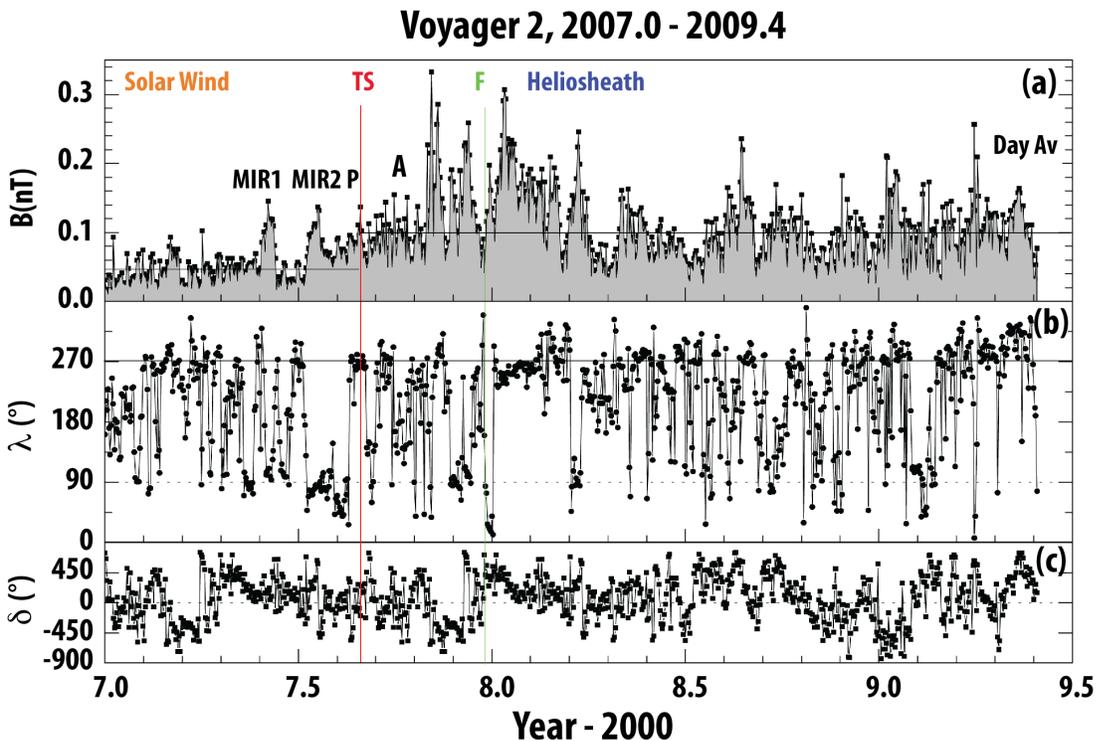
Light curves (normalized, and displaced for clarity) derived from rapid-cadence (10 s) CDS spectra obtained at the same location in which AIA observed a non-flare brightening. The GOES, RHESSI (not shown here), and CDS Fe XIX light curves all show that the brightening did not produce 10-MK plasma.

Leonard Burlaga



Dr Burlaga is an astrophysicist specializing in the structure and dynamics of the heliosphere and its interaction with the interstellar medium. He has spent over 40 years in space research at GSFC and now serves in an emeritus status. He is a Co-I on the magnetic field and plasma instruments on Voyager 1 and 2, the SECCHI instrument on STEREO, the magnetic field instrument on ACE, the plasma instrument on WIND, and a theoretical team studying the dynamics of the distant heliosphere. He received his BS degree from the University of Chicago and a MS degree and PhD from the University of Minnesota. He joined GSFC in 1968.

Voyager 2 crossed the termination shock in August 2007, near 84 AU, and it is providing new insights into the nature of the heliosheath. Towards the end of 2008 (near the feature “F” in figure below), a change in the magnetic polarity pattern was observed, suggesting that Voyager 2 was leaving the sector zone and entering the fast flows from the south polar coronal hole, as a consequence of the decreasing latitudinal extent of the heliospheric current sheet associated with the approach to solar minimum. This transition from one polarity pattern to another and the interval following this transition were associated with intense and variable magnetic fields in the heliosheath, which are not understood.



The magnetic field strength B , azimuthal angle λ , and elevation angle δ observed by Voyager 2 in the solar wind and in the heliosheath following crossing of the termination shock (TS).

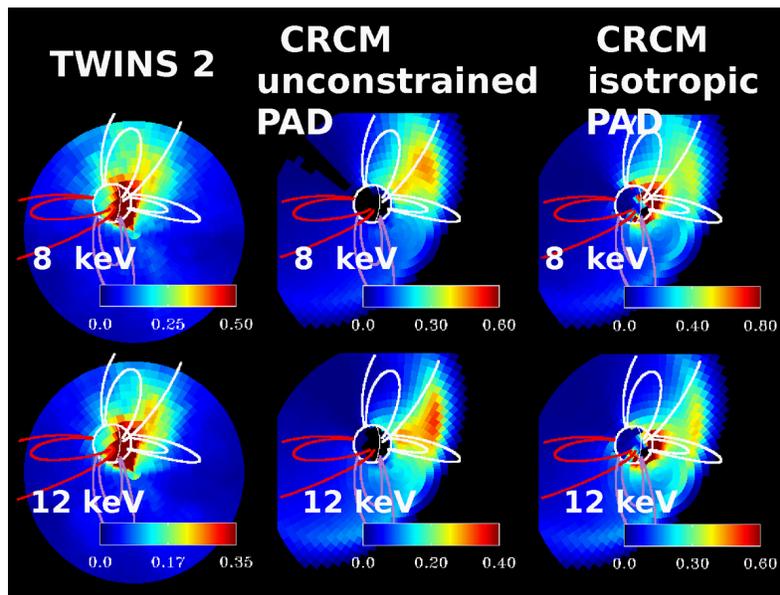
Natalia Buzulukova



Natalia Buzulukova graduated from the Moscow Institute of Physics and Technology and obtained her PhD from the Moscow Space Research Institute (Russia) in 2003. She has been working at GSFC since May 2007, first as an NPP fellow (May 2007 through May 2010) and then as a Visiting Assistant Research Scientist at the University of Maryland at College Park (UMCP). Natalia is working with Mei-Ching Fok on modeling of the inner magnetosphere with a CRCM model (ring current-plasmasphere-ionosphere coupling) and data analysis from NASA missions.

Dr Buzulukova’s work involves modeling of the electrodynamic and plasma dynamics of the Earth’s inner magnetosphere, including simulation of terrestrial ring current and associated ENA emissions. Her work also includes data analysis from past and current NASA missions such as IMAGE, THEMIS and TWINS. She is trying to extract and study the relations between different processes and different domains in the inner magnetosphere. To know how inner magnetosphere evolves is critical for space weather applications and understanding the effects of solar activity on the Earth and its space environment.

In 2010, Dr Buzulukova has continued to work with data analysis and modeling of ENA images acquired by two TWINS spacecrafts. She has used CRCM model to calculate 3D fluxes and reproduce ENA images. Comparing real ENA images with modeled ones, she has isolated and studied different aspects of ring current dynamics during geomagnetic storms. Several storms during the last deep solar minimum were included in the studies. Three papers have been accepted for publication in JGR Space Physics. She also has participated in two TWINS science team meetings (February 2010, San Antonio, TX and August 2010, Laurel, MD).



TWINS 2 ENA images of ring current on 2008 October 11 and synthetic CRCM images. An effect of pitch-angle distribution is shown.

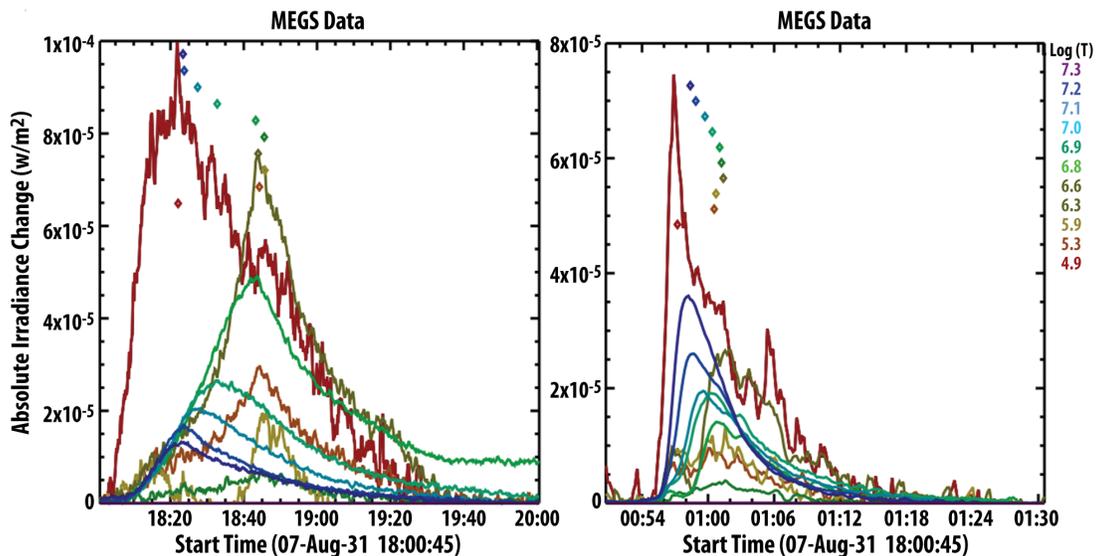
Phillip C. Chamberlin



Dr Phillip Chamberlin is a research astrophysicist in the Solar Physics Laboratory and a deputy project scientist for the Solar Dynamics Observatory (SDO) that recently launched in February 2010. He received his BA degree from Hanover College in 2001, and his MS degree (2003) and PhD (2005) in aerospace engineering sciences from the University of Colorado while working as a graduate research assistant at the Laboratory for Atmospheric and Space Physics (LASP). Dr Chamberlin did his post-doctoral work in 2006 through 2007 at LASP, and then for two years as a Research Scientist II before coming to GSFC in July of 2009.

Dr Chamberlin's research is focused primarily on measuring and modeling of the solar X-ray and UV irradiance. Dr Chamberlin leads the continued improvement of his Flare Irradiance Spectral Model (FISM), continues to work with data from TIMED-SEE, helped launch and analyzed the data from the SDO/EVE underflight calibration sounding rocket (May 2010), continued input to the development of an EUV spectrometer for the future MAVEN mission, and was just awarded an independent research and development (IRAD) grant to develop a future solar imaging spectrograph call the Lyman Alpha Doppler Imaging Interferometer (LADII).

A highlight of the past year's work by Dr Chamberlin has been the analysis of the data from SDO, specifically the EVE instrument for which he is a CO-I. Due to the spectral range and resolution of EVE, as well as the 10-second cadence and 100% duty cycle, the temperature evolution from flares can be observed and the radiated energy in the EUV wavelengths (0.1-106 nm) quantified. He has shown that the temperature evolution and energy output, as can be seen in the figure, are very different between an impulsive flare and a gradual, two-ribbon flare, though both are of a similar magnitude (M1 and M2).



Flare plasma temperature evolution (with diamonds showing the timing of peak temperature) and absolute radiated emissions for the M2.0 compact flare on 2010 June 12 and M1.0 two-ribbon flare on 2010 August 7.

Peter C. Chen



Peter Chen was born in Chengdu, Sichuan, China. He obtained his BSc degree in Mathematics and physics from the University of Toronto, Canada, and his PhD in astronomy from Case Western Reserve University, Cleveland, Ohio. He was a postdoctoral fellow at the Department of Astronomy at the University of Texas, Austin. He came to GSFC in 1983 to work on the Ultraviolet Imaging Telescope (UIT) science, instrumentation, and operations teams. He supported the UIT during the Astro-1 mission of 1990 and the Astro-2 mission of 1994. Since 1996, Dr Chen has worked at GSFC on the development of advanced instrumentation and concepts, such as:

High Tc Superconductor Bearings



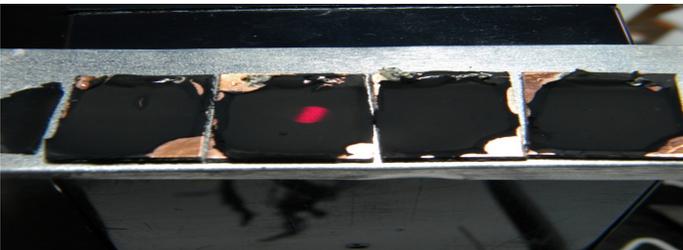
A Questar telescope levitated on a high Tc superconductor bearing. Developed by P. Chen and D. Rabin under a grant from the LUNAR Institute, University of Colorado at Boulder.

Carbon Fiber Mirrors



Child holding a 50-cm very lightweight mirror made of carbon fibers, carbon nanotubes, and polymer. P. Chen and D. Rabin.

Carbon Nanotubes

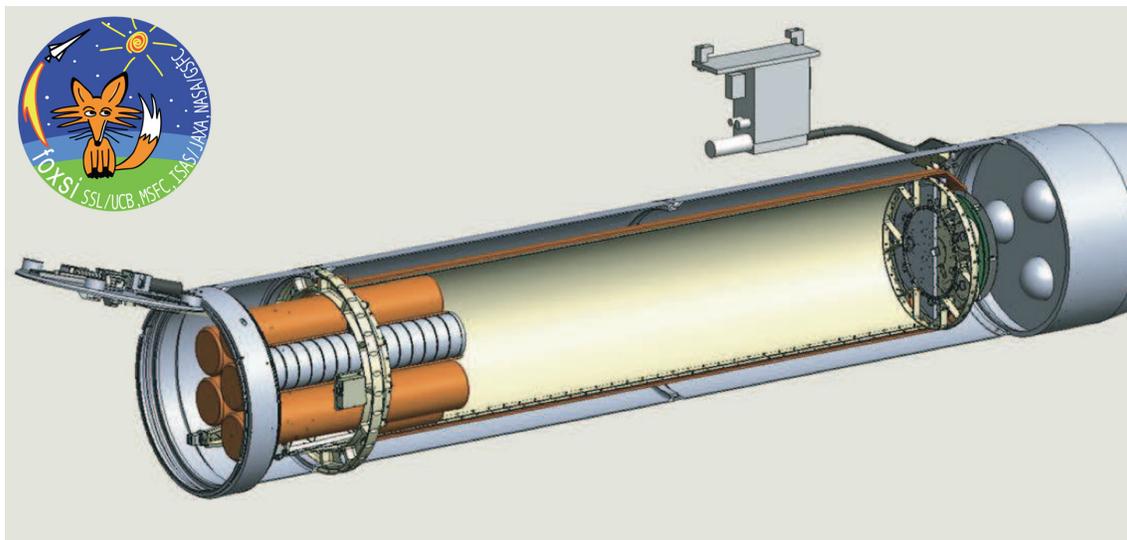


Laser spot on a surface of aligned carbon nanotubes. P. Chen and J. Hagopian (Code 551) collaborated on a NASA IPP grant to develop large area extremely low reflectance surfaces for stray light suppression in space telescopes.

Steven D. Christe



Dr Steven Christe is a research astrophysicist in the Solar Physics Laboratory. He received his BS degree in physics and mathematics from the State University of New York at Stony Brook. Switching coasts, Dr Christe received his PhD from the University of California (UC), Berkeley, at the Space Sciences Laboratory under Professor R. P. Lin. During his graduate studies, working with Dr S. Krucker, he created and analyzed the largest database of hard X-ray microflares observed by RHESSI. In parallel, he developed a sounding rocket program, the Focusing Optics X-ray Solar Imager (FOXSI), to study solar microflares, which was successfully proposed to the NASA SR&T LCAS program in 2007. The FOXSI program is a partnership between the Space Sciences Lab UC Berkeley, MSFC and the Japanese Astro-H mission led by Professor T. Takahashi.



The FOXSI payload inside a 22 in. rocket skin: The basic structure of the payload consists of a 2-m long rolled aluminum tube, which holds an array of seven optics and seven detectors at either end. Active cooling of a thermal mass to -30°C with LN₂ prior to launch will keep the detectors below -20°C during the flight. The payload will be oriented “backwards” within the rocket as the detector end is located at the front of the rocket. Separation of the rocket engine will allow the optics to be revealed after opening the telescope door.

As a post-doctoral researcher at the Space Sciences Laboratory, Dr Christe oversaw the FOXSI program as the Project Manager/Scientist. These responsibilities continued after he joined the GSFC in the fall of 2009. Currently, Dr Christe is working on several projects including, developing novel Transition Edge Sensors (microcalorimeters) under the IRAD program, continued work on microflares through combined RHESSI and SDO observations and investigating the flare productivity of active regions.

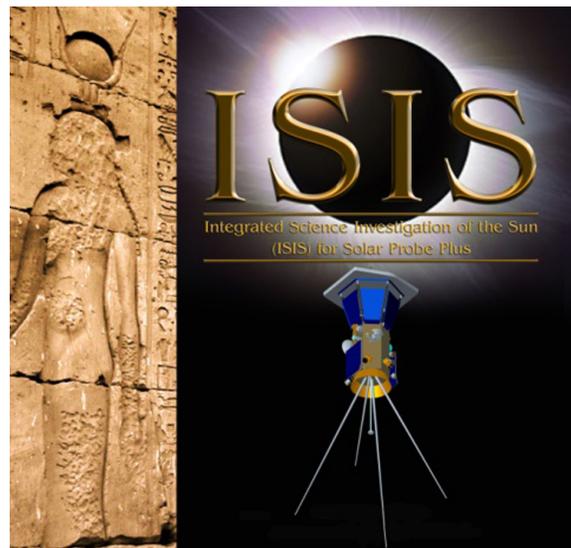
Eric R. Christian



Dr Christian was born in New Jersey. He received his BA degree in physics (with Honors) and astronomy from the University of Pennsylvania in 1982, and a PhD in astrophysics from the Caltech in 1989. He then started working in the High Energy Astrophysics Laboratory at GSFC as a Universities Space Research Association contract scientist on many spacecraft and balloon-borne energetic particle detectors including ACE, ALICE, Astromag, IMAX, ISOMAX, and TIGER. In 2002, he took a “temporary” position as a program scientist at NASA Headquarters, but a civil servant position as the Solar Terrestrial Probes Program Scientist convinced him to stay longer. He returned to GSFC in 2008.

Dr Christian is working on a number of energetic-particle detectors that span an energy range from 10 eV (IBEX) to tens of GeV (Super-TIGER). Most of the energetic particle instruments that he works on (ACE/CRIS, ACE/SIS, STEREO/IMPACT/HET, and IBEX) are launched and operational. Currently, Super-TIGER, a balloon-borne spectrometer, is under construction. He is Deputy PI and spent a considerable amount of time writing the ISIS proposal for SPP. He is a Co-I on the I-EPI-HI instrument for SPP that was selected and is currently in Phase A. Dr Christian’s scientific interests are related primarily to the origin of energetic particles, including ENAs (IBEX), solar energetic particles (ACE/SIS, STEREO/IMPACT/HET, and SPP/I-EPI-HI), anomalous cosmic rays (ACE/SIS), and galactic cosmic rays (ACE/CRIS and Super-TIGER).

Dr Christian is Deputy Project Scientist for ACE and STEREO, Deputy Mission Scientist for IBEX, and Standing Review Board member for RBSP, and was a member of a NASA Procurement Development Team for Web Enterprise Service Technologies which finished this year. He is a science team member on multiple projects (ACE, IBEX, SPP, STEREO, and Super-TIGER) with many universities, primarily Caltech, JPL, Washington University in St. Louis, and SWRI. He also actively participates in EPO activities for the HSD.

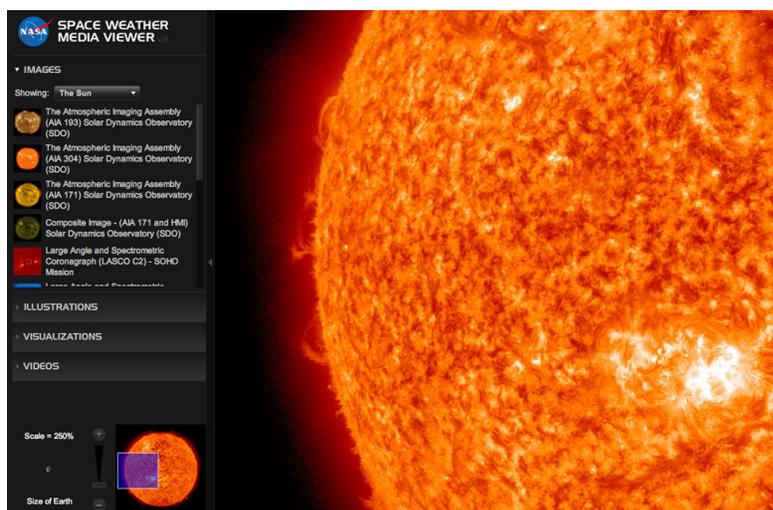


Troy Douglas Cline



Mr Cline is the EPO Lead for the Magnetospheric Multiscale (MMS) mission. He is responsible for mission level public outreach activities and coordination of overall E/PO efforts. His responsibilities include planning, coordinating, implementing and managing the MMS mission's outreach activities to meet NASA's E/PO goals and guidelines. He also serves as the Educational Technology Integration Specialist for NASA's Sun-Earth Day and Space Weather Action Center programs. He provides ongoing educational technology support and leadership in the development and distribution of educational programs and materials reaching over 50 million people worldwide.

His research-based approach led to the development of a new heliophysics education program that allows students to create Space Weather Action Centers in their schools. These centers encourage students to collect space weather data from existing resources (see the figure below), analyze that data and deliver inexpensive video reports on a variety of heliophysics topics. He continues to lead his team in social media integration, applications and in the development of new podcasting programs



The Pirelli Award winning Space Weather Media Viewer allows users to quickly access and analyze near-real time images of the sun from a variety of satellites and ground-based observatories.

Before coming to NASA, Mr Cline was a high school mathematics teacher and Educational Technology Coordinator at an alternative high school in Virginia, working with “at-risk” students. While there, he led the creation and maintenance of an Instructional Technology Plan leading to the integration of current and accessible technologies into educational curriculum. Prior to working in Virginia, his teaching career took him to some exceptional places beginning with his first teaching experience on the Navajo Indian Reservation in Kinlichee, AZ. While there he taught in a Bureau of Indian Affairs boarding school for three years. He later joined the United States Peace Corps and served as an algebra and geometry teacher in Chad, Africa, where he led the development of a French/English mathematics database consisting of proven lesson plans and educational methodologies.

Yaireska Collado-Vega



Yaireska (Yari) Collado-Vega is a fourth-year physics PhD candidate student at The Catholic University of America in Washington, DC. She is originally from Ponce, Puerto Rico, and has been living permanently in Maryland for over three years. She is part of the Graduate Cooperative Education Program (Co-op) at GSFC under the Geospace Physics Laboratory (Code 673).

Ms Collado-Vega has been part of the GSFC family since August 2004. She received both her BS and MS degrees in theoretical physics from the University of Puerto Rico at Mayagüez, Puerto Rico, in 2004 and 2007, respectively. She also received her second MS degree from The Catholic University of America on May 2010.

Ms Collado-Vega started 2010 finishing her research on visualizing vortices caused by instabilities along the Earth's magnetopause, using MHD simulations: the Lyon-Fedder-Mobarry (LFM) code and the BATS-R-US code. Vortices were found with both fixed and dynamic data for comparison and many curious development characteristics were identified. The results were presented at the SED Director's seminar at GSFC in February, and at a poster session at the GEM Meeting in Snowmass, CO, in June. A research paper is being completed and will be submitted to the Journal of Geophysical Research.

Ms. Collado-Vega's current research is based on studying Flux Transfer Events (FTEs) on the magnetopause. These signatures, which usually occur during transient times of reconnection, exhibit bipolar signatures in the normal component of the magnetic field. She uses the bipolar magnetic field signatures and magnetic field strength variations observed by all four Cluster spacecraft in 2002 and 2003 to determine the velocity and direction of FTE motion for comparison with predictions for the motion of FTEs generated by the component and anti-parallel reconnection models. These results were presented at the Fall AGU meeting in San Francisco, CA.

At GSFC she has also been involved in E/PO activities from the Science Exploration Directorate for middle/high school and college undergraduate students to encourage them to pursue the field of science in the near future.

Glyn Collinson



Dr Collinson obtained a MSc in physics from the University of Bristol, and his PhD from University College London in 2010 designing the Electron Spectrometer for ESA's upcoming Solar Orbiter mission. He is an instrument scientist who works on in situ space plasma instrumentation.

Dr Collinson joined GSFC as a part of the NASA Postdoctoral Program in January 2010, fresh from his PhD at Mullard Space Science Laboratory. The primary focus of his research is the development of revolutionary space plasma instrumentation that will measure electrons or ions up to 5keV at very high cadence (30 fps). Unlike traditional "top hat" analyzers,

DRIVEN (Deployable Radial Imaging for Velocity, Energy, and Density) will directly image space plasma distributions. It will be ideal for the measurement of ionospheric plasma or the solar wind. This year has seen the completion of an exhaustive electron optical design process for DRIVEN. The new electrostatic analyzer has the potential to offer an order of magnitude or greater improvement in the energy range of plasma sensors in its class.

This year, he applied for and won \$50K Innovation Partnerships Grant with which he bought a detector for DRIVEN, and hired a NASA mechanical engineer to develop the concept into a practicable design.

In addition to his blue-skies research, he is the technical lead for the electron optics of the Magnetospheric Multiscale Mission (MMS) Dual Electron Spectrometer (DES) investigation. This instrument is required to make electron measurements at unprecedented spatial and temporal resolution and thus make the first ever measurements of electron diffusion during magnetic reconnection. He is currently developing a laboratory plan to investigate and validate the response of the DES Engineering Test Unit (ETU), which is the last stage in the development of DES before the construction of the 16 flight models (32 electrostatic analyzers in total, making this by far the most ambitious space plasma instrument suite ever).

In the coming year, he hopes to develop DRIVEN further, help characterize the performance of the MMS DES, and study the solar wind interaction with Venus.

John F. Cooper



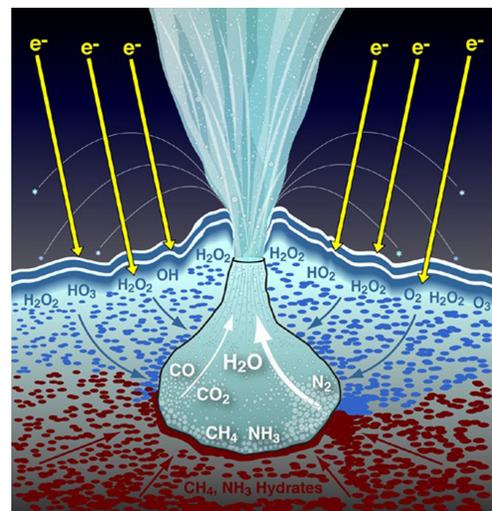
Dr Cooper was born a true “Son of the South” in Savannah, Georgia. He obtained his BS degree in physics from Georgia Institute of Technology and after three years of active duty service as an officer in the U.S. Navy, he was awarded his PhD in physics from the University of Chicago. Afterwards he worked in postdoctoral research at the Max Planck Institute for Extraterrestrial Physics in Munich, Germany, in the Space Radiation Laboratory of the California Institute of Technology and in the Department of Physics and Astronomy at Louisiana State University.

In 1990 Dr Cooper joined ST Systems Corporation (STX) at GSFC to begin many years of work in support of the National Space Science Data Center and what later became the Space Physics Data Facility. The STX work continued through corporate and contract transitions to Hughes, STX, and Raytheon ITSS before he joined NASA as Chief Scientist for SPDF in 2005. During the contractor and NASA civil servant years Dr Cooper continued research on space radiation environment interactions with icy bodies of the outer solar system and served as Principal Investigator on many science investigations, now including two projects respectively on space weather and Europa magnetospheric interactions for the Outer Planets Research program, a third called LunaSOX (Lunar Surface Origins Exploration) on solar wind plasma interactions with the Moon for the Lunar Advanced Science and Exploration Research (LASER) program, and a fourth on his Virtual Energetic Particle Observatory (VEPO) for the Heliophysics Virtual Observatories program. He is also a member of the GSFC science team for the Cassini Plasma Spectrometer (CAPS).

Products of continuing projects include new or updated Web sites serving to distribute data and information to the relevant research communities and the public to include VEPO project data at <http://vepo.gsfc.nasa.gov>, LunaSOX project data and services at <http://lunasox.gsfc.nasa.gov>, and his IPY-IHY archival site at <http://polargateways2008.gsfc.nasa.gov> for the Polar Gateways Arctic Circle Sunrise conference he chaired in January 2008 at the “Top of the World” in Barrow, AK.

In recent research Dr Cooper has been active in the general area of space weather modifications of planetary surfaces and atmospheres from Europa in the Jovian magnetosphere to Enceladus and Titan in the Saturn magnetosphere to Kuiper Belt Objects in the outer heliosphere. The figure shows an illustration for his theory of cryovolcanism driven at Enceladus by gases arising from radiolytic chemistry for magnetospheric electron irradiation of the moon’s icy crust.

Saturn magnetospheric electrons irradiate the ice surface of Enceladus and produce oxidants that later interact with CH₄ and NH₃ to produce cryovolcanic gases



Aaron J. Coyner



Dr Coyner was born in Norman, Oklahoma. He obtained his BS degree in engineering physics from the University of Tulsa in 2003. He obtained his MS degree from Rice University in 2005 and subsequently his PhD from Rice University in 2008. He joined GSFC by way of Catholic University in August, 2008 and has been diligently exploring EUV spectra and observational constraints for coronal heating for the last two years.

In FY2010, Dr Coyner continued his investigation, under the guidance of Joe Davila, into statistically constraining the non-thermal velocities observed in EUV spectra by using SERTS observations. These non-thermal velocities have been noted as a key signature of disparate models of coronal heating, and the SERTS instrument observed coronal plasma at temperatures of 1–2 MK, temperatures where the coronal heating signatures should be visible. Surprisingly, Dr Coyner and Dr Davila found a consistent non-thermal broadening corresponding to a velocity of 23–24 km/s in both active regions and quiet-Sun corona. The results suggested, that the non-thermal motions observed by SERTS were consistent regardless of solar activity level and likely originate from a common mechanism, although energy estimates indicate that they are insufficient sources of energy to be signatures of coronal heating. He presented these results at the AGU Fall Meeting in San Francisco, CA.

Dr Coyner then extended this analysis to spectral observations from Hinode/EIS to use the improved instrumentation of EIS to further investigate these non-thermal velocities to compare the results from EIS observations to the results from the SERTS flights. He presented preliminary results from this initial comparison of EIS and SERTS observations at the Solar Physics Division meeting as part of the 216th AAS Meeting in Miami, FL, in May 2010.

Joseph M. Davila



Dr Joseph M. Davila is the Senior Scientist for Heliophysics. He is Mission Scientist for the IRIS mission and led it to a successful confirmation. He led the SPICE EUV spectrograph's successful Phase A. He teamed with Observatoire Astronomique Marseille-Provence Laboratoire d'Astronomie Spatiale (OAMP) to propose the recently selected Association de Satellites Pour l'Imagerie et l'Interférométrie de Couronne Solaire externally occulted coronagraph for the ESA PROB3 two spacecraft formation flying technology mission. Dr Davila leads the International Space Weather Initiative (ISWI); adopted in a resolution of the UN General Assembly as a sponsored project of the Committee for the Peaceful Uses of Outer Space.

Dr Davila was PI for an investigation of a new-technology polarization camera that will improve the quality and reliability of data from coronagraphic instruments by replacing discrete polarizer mechanisms with a polarization-analyzing sensor. He was co-author on nine refereed papers. He leads the development of 3D and tomographic models of solar phenomena utilizing STEREO data (five papers); he reported results for a new coronal diagnostic instrument tested during the 2006 eclipse in Libya; he co-authored two papers on the Hinode EIS data providing critical calibration information from the EUNIS, and reporting the observation of slow-mode waves in coronal structures; and he published another paper utilizing SERTS spectra.

He collaborates with MSFC on the Hinode mission. He also collaborates with the Japanese Space Agency on the definition of the Solar C mission. He is the lead organizer for the United Nations–NASA Workshop to be held in Egypt in November 2010. Results: Collaboration on Solar C definition has laid foundation for NASA participation in this important mission. UN outreach on space weather has secured new ionospheric and solar data sets for space weather. Dr Davila is a leader in the development of externally occulted coronagraphs that will provide the spatial resolution necessary to image the changes in the coronal leading to flares. He teamed with OAMP to propose the recently selected Association de Satellites Pour l'Imagerie et l'Interférométrie de Couronne Solaire externally occulted coronagraph for the ESA Proba-3 two spacecraft formation flying technology mission. Dr Davila provided leadership for four post-doctoral researchers and a UMCP graduate student who will be defending her dissertation (which utilizes STEREO data) in October 2010.

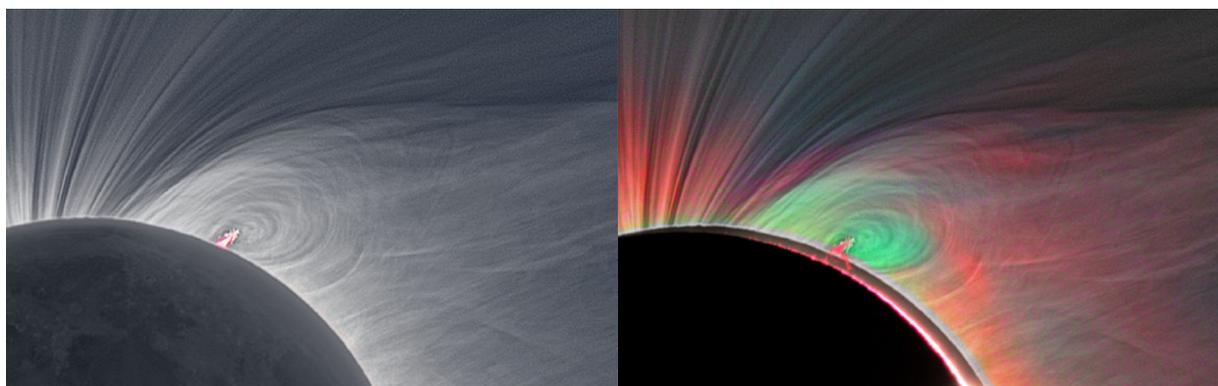
Dr Davila initiated and organized the presentation of a COR1 (STEREO) instrument mock-up for the Visitors Center at the UN in Vienna. The presentation was made on behalf of the US by Ambassador Glyn Davis. This instrument has provided the nucleus of a new Space Weather exhibit at the UN which includes space weather informational material as well as a working ionosphere monitor providing real-time data on space weather effects. He chaired scientific sessions at the Space Weather Forum and at the COSPAR Conference. He was interviewed on camera for the National Geographic Special about the total solar eclipse of July 2010. Dr Davila met with the Director General of the Korean Radio Research Agency, as well as other Korean and US officials, to discuss Korean space weather initiatives as well as downlink support for the NASA Advanced Composition Explorer (ACE) mission.

Adrian N. Daw

Dr Daw joined Code 671 at GSFC as a research astrophysicist in August 2009, which was preceded by five years as a professor in the Department of Physics and Astronomy at Appalachian State University, four years as a visiting scientist at the Smithsonian Astrophysical Observatory, a PhD (2000) and AM degree in physics from Harvard University, and a Bachelor of Arts degree from Yale University. His research includes extreme UV spectroscopy of the solar corona: gearing up for the 2011 EUNIS sounding rocket launch by cooling detectors and adding optics to study new wavelengths, and for a 2012 Explorer launch as Deputy Mission Scientist for IRIS and as Co-I on a FY2010 IRAD project to develop image slicer technology for UV integral field spectroscopy.

This year, Dr Daw joined the CLARREO Reflected Solar Spectrometer team, who are pushing the envelope on calibration techniques in order to provide absolute radiance measurements from the UV to the NIR as part of the most accurate climate data set ever. He also began collaborating with the U.S. Air Force Academy on FalconSAT-7, a project to obtain narrowband solar images from a 3U CubeSat by using a new diffractive optic called a photon sieve, which can be deployed on a membrane larger than the spacecraft. This technology will lead to an order-of-magnitude improvement in optical imaging resolution from space.

Dr Daw is PI on a 2011 IRAD to develop this technology at GSFC in collaboration with the USA Academy. Other collaborations include the University of Hawaii and Brno University of Technology (Czech Republic), on polarimetric imaging of NIR-visible coronal lines, and collaborations with Appalachian State University and Columbia University on laboratory measurements of atomic and molecular parameters for heliospheric ions. Dr Daw and his colleagues obtained full-Sun images in NIR-visible lines of seven coronal ions during the 2010 total solar eclipse from Tatakoto in French Polynesia, while analysis of previous eclipse data with Shadia Habbal, Milos Druckmüller, and others revealed that prominences are enshrouded in hot plasmas within twisted magnetic structures.



Left: White light image during the total solar eclipse of 2008. Right: Overlay of emission from “cool” Fe X / Fe XI in red and “hot” Fe XIII / Fe XIV in green on the white light, with chromospheric emission just prior to totality shown as well. These are the first multi-wavelength observations of prominence “cavities” revealing their temperature.

Brian R. Dennis

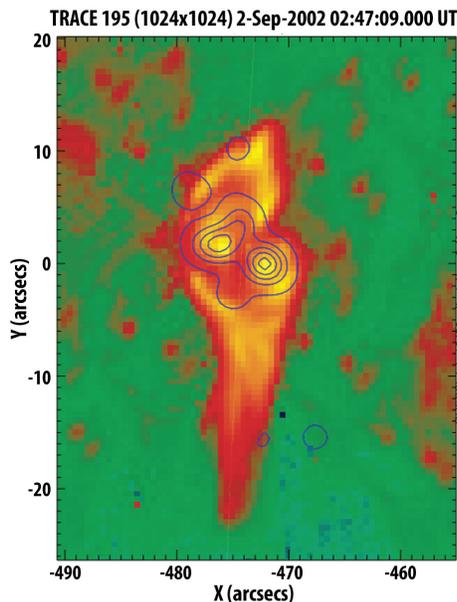


Dr Dennis was born in Lincolnshire, England and obtained a BSc degree and PhD from the University of Leeds. He emigrated to the United States in 1964 to the University of Rochester, New York, and moved to GSFC in 1966 as an NRC postdoctoral scientist. Dr Dennis became a civil servant in 1969 and worked in the Solar Physics Branch on the observations and interpretation of X-rays, initially as part of the cosmic X-ray background and since 1980 from solar flares. He is RHESSI Mission Scientist and Co-I. Dr Dennis is working in collaboration with the PI team at the Space Sciences Laboratory of the University of California, Berkeley.

Dr Dennis is PI on the following projects:

- VxO for Heliophysics: Extending the VSO Incorporating Data Analysis Capabilities
- Low-cost Access to Space: Imaging X-ray Polarimeter for Solar Flares
- Fermi GI: Fermi Solar Flare Observations
- GSFC Spontaneous IRAD: X-ray Diffractive Optics

Dr Dennis’ research areas include understanding the energy release and particle acceleration processes in eruptive solar events as well as developing new and advanced techniques for imaging, spectroscopy, and polarimetry of X-rays and γ -rays from the Sun and other astrophysical sources of interest. He also works on performing instrumentation, data analysis, data interpretation, theory and modeling and technology development.



TRACE 195-Å image of a flare on 2 September 2002 at 02:47 UT, with the overlaid RHESSI 1- to 25-keV blue contours showing the tight correlation between the bright EUV emission and the two hard X-ray sources most probably at the foot-points of a flaring magnetic loop.

Georgia A. de Nolfo



Dr de Nolfo obtained her BS and MS degrees in physics from the University of Chicago and her PhD from Washington University in St. Louis in 1997. Afterwards, she joined the California Institute of Technology as a postdoctoral fellow, where she worked in the field of high-energy cosmic-ray astrophysics. In 2001, Dr de Nolfo was awarded an NRC Fellowship to work at NASA GSFC.

For the past ten years, Georgia has focused on instrument development and the analysis of both space-born and high-altitude balloon-born cosmic-ray instruments. She was a Co-I on several high-altitude balloon-borne missions including ISOMAX, TIGER and currently Super-TIGER, developed to measure the elemental and isotopic composition and intensity of GeV-range galactic cosmic rays. She also works on the analysis of the light isotope cosmic-ray data from the Cosmic Ray Isotope Spectrometer (CRIS) on ACE. In 2008, Dr de Nolfo shifted her research focus toward instrument development of γ -ray and neutron imagers and the study of the connections between solar flare physics and solar energetic particles. She joined HSD in August 2010. During 2010, Dr de Nolfo was a Co-I on a neutron/ γ -ray spectrometer proposal for Solar Probe Plus and is currently a Co-I on a three-year NASA/APRA funded program, with PI Dr Stan Hunter (GSFC/661), to develop the Three Dimensional Track Imager (3DTI) technology for γ -ray and neutron imaging. The 3DTI technology combines a large volume time-projection chamber with two-dimensional micro-well readout.

The Neutron Imaging Camera (NIC) is funded by the Office of Naval Research. This technology reduces the effective lower energy cut-off for pair-production imaging of γ -rays to ~ 5 MeV to be imaged via pair production, whereas neutrons are imaged through the detection of (n,p) interactions in high proton content gas mixtures such as methane. Dr de Nolfo has spent the year developing simulation software to characterize the NIC. A significant milestone was reached this summer with a successful field test of the NIC camera using neutron sources using both static and dynamic scenarios at various distances over water. NIC was able to register and image the sources successfully. Dr de Nolfo's simulations agree with the data and her simulation results to calibrate the energy response of NIC. She is excited about the prospect of using the rate data from the silicon solid-state detectors on ACE/CRIS to measure or monitor the high-energy proton intensity during solar events. The CRIS rate data may prove to be a valuable data set for measuring protons during solar particle events that bridge a gap in energy between low energy spacecraft measurements and ground level events.



Testing the NIC on a floating dock.

John C. Dorelli

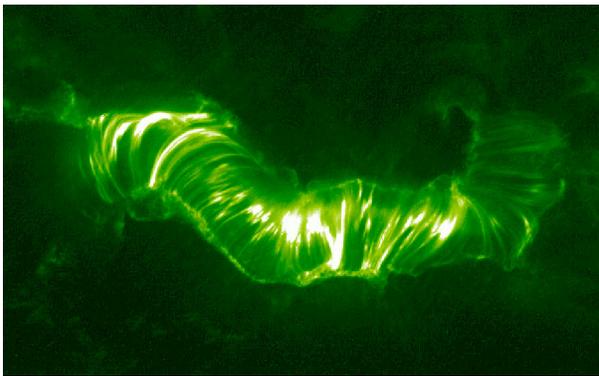


Dr Dorelli joined the Geospace Physics Lab (Code 673) in March of 2009. His primary interest is in the physics of solar wind-magnetosphere coupling, but he has also worked on modeling of the solar corona as well as the physics of collisionless magnetic reconnection. During the last few years, he has used a combination of large-scale MHD simulations (spanning hundreds of Earth radii) and small-scale Hall MHD simulations (spanning tens of ion inertial lengths) to understand both the global topology and local geometry of magnetic reconnection at Earth’s dayside magnetopause.

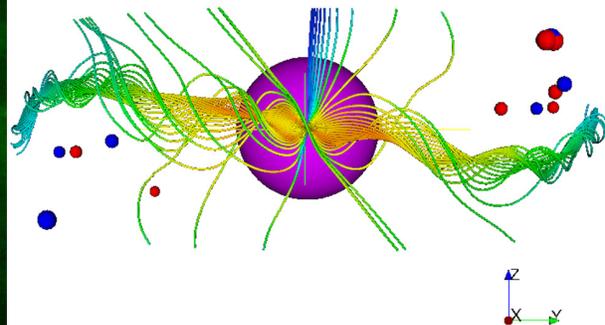
More recently, Dr Dorelli became involved in modeling the response of the Fast Plasma Instrument (FPI) which is under development at GSFC as part of NASA’s Magnetospheric Multiscale Mission (MMS). FPI will make plasma measurements with unprecedented temporal resolution in Earth’s dayside magnetopause and magnetotail, providing the first detailed look at the fundamental process of magnetic reconnection (the ultimate driver of aurorae and magnetic storms).

Dr Dorelli received his PhD from the University of Iowa in 1999. While at Iowa, he split his time between developing and testing in-flight calibration algorithms for NASA’s Polar-Hydra instrument (a suite of electrostatic analyzers designed to measure three-dimensional velocity distributions in Earth’s magnetosphere) and modeling non-classical electron heat flow in the solar corona.

For the last several years, Dr Dorelli has been actively involved in the NSF’s Geospace Environment Modeling program, serving as a Dayside Research Area coordinator as well as co-organizer of the Methods and Modules Focus Group.

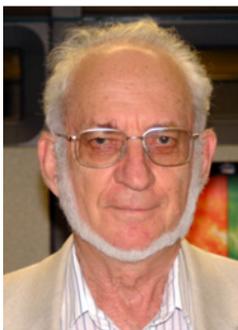


Magnetic flux ropes play an important role in the generation of “solar storms” (e.g., solar flares and CMEs). This figure shows an EUV image, taken by TRACE, of the “Bastille Day” solar flare (2000 July 14).



A simulated “Flux Transfer Event” at Earth’s dayside magnetopause suggests that similar physics (involving explosive “magnetic reconnection”) may be responsible for the triggering of magnetic storms in Earth’s magnetosphere.

Richard J. Drachman



Dr Drachman was born in New York City. He received all his academic degrees (Bachelor of Arts, Master of Arts and PhD in physics) from Columbia University, after having graduated from Brooklyn Technical High School. He spent two summers at Brookhaven National Laboratory, but his first real employment was at the Naval Research Laboratory, during which time he took a trip around the world in connection with some spectacular nuclear fireworks in the Marshall Islands. Dr Drachman next spent four years as Assistant Professor of physics at Brandeis University. During part of this time he earned a private pilot's license and served as a consultant for a nuclear propulsion project. All good things must end, but the next good thing was transfer from NRL to GSFC, where he has been almost forever.

At GSFC, Dr Drachman has been able to concentrate on his favorite subject, antimatter, both its quantum-mechanical basis and its importance in astrophysics. Positrons, the lightest kind of antimatter, are produced by various processes at the galactic center, in energetic flares on the Sun, and in the decay of some radioactive nuclei in space. Their interactions with normal matter gives rise to gamma radiation whose detailed study can lead to better understanding of the source regions. Dr Drachman has published a large number of papers on these questions in *The Physical Review*, *Journal of Physics*, and *The Canadian Journal of Physics* (CJP).

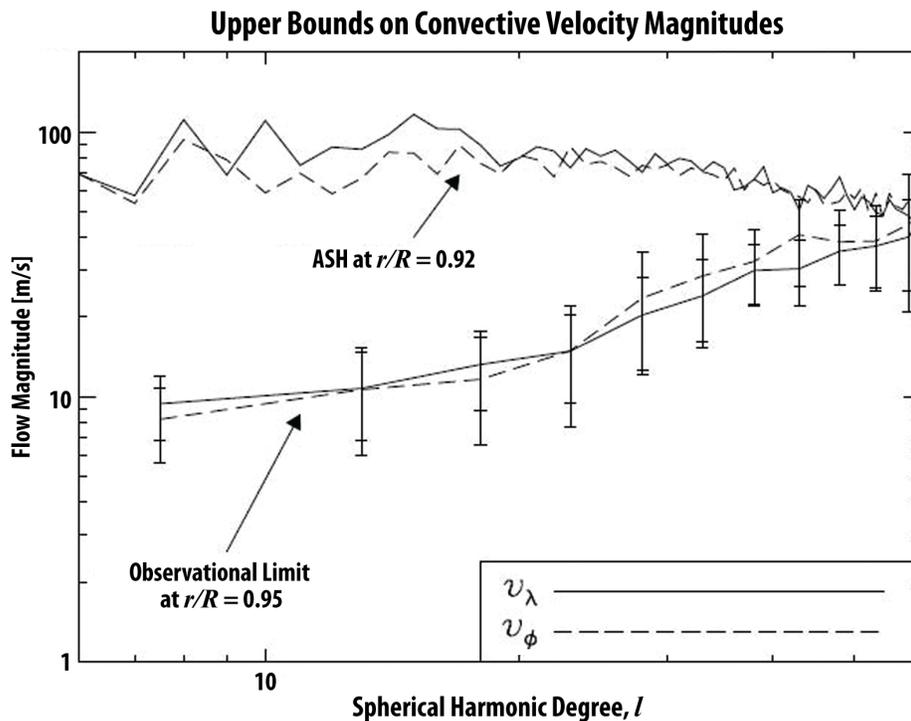
During the past year he and his colleague Joseph Di Rienzi (College of Notre Dame of Maryland) have submitted an intricate paper on positronium resonances three times. The last version of the article was accepted for publication in CJP. Dr Drachman actually believes that the harsh reviews the work received improved it. Present work with Anand Bhatia on hydrogen polarizability in a plasma is ongoing and almost complete.

Thomas L. Duvall Jr.



Dr Duvall is an astrophysicist studying the Sun and has been doing so in the employ of GSFC for 30 years. His training is mainly in physics with degrees from Johns Hopkins (BA) and Stanford University (PhD)

Dr Duvall normally works remotely from GSFC at Stanford University with the instrument group that has developed the MDI instrument on SOHO and the HMI instrument on SDO. This has been a busy year with the successful launch of SDO. He has continued work with his former student, Shравan Hanasoge, on the comparison of helioseismic data analysis with simulations. The ASH (anelastic spherical harmonic) code is used by simulators to predict how vigorous is convection in the Sun. The result of such a calculation is shown in the top two curves in the figure below.



An acoustic simulation is used to calibrate the helioseismic travel times which then leads to an upper limit of the convective flow magnitudes (lower two curves in the figure). The discrepancy in the figure, in which the predicted flow is larger than the upper limit of the measured flows, suggests that something is wrong with the modeling. (The pairs of curves correspond to the two components of horizontal velocity.)

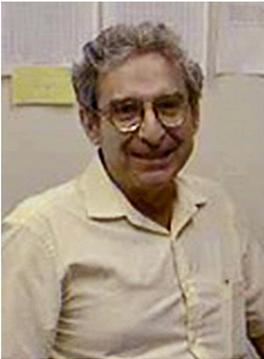
Kimberly A. Engle



Dr Engle (ADNET, Inc.) received her PhD in physics (astrophysics thesis) in 1999, and joined Code 672 in August 2010 after over 11 years of service with Code 660. Her background is in astrophysics research, computer systems administration on a variety of platforms and operating systems, and experience parallel programming and supercomputing.

She is working with Dr Szabo, Dr Merka, and T Narock as a scientific programmer supporting the Virtual Heliophysics Observatory (VHO) and Virtual Magnetospheric Observatory (VMO), a NASA Web service designed for remote users to be able to search for and retrieve easily and readily various solar physics data products stored on sites around the world.

Joseph Fainberg

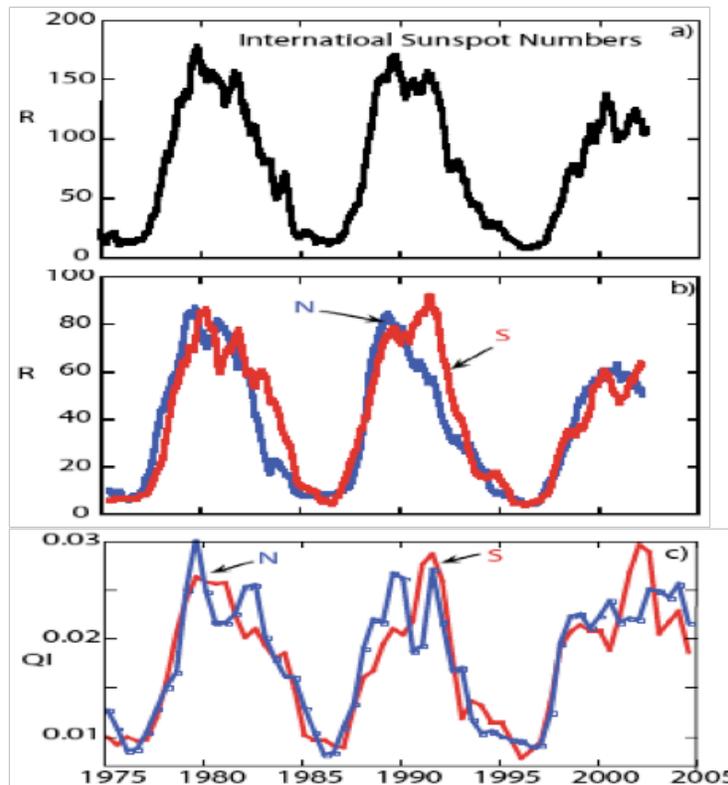


Dr Fainberg has spent over 40 years in space research at GSFC and now serves in an emeritus status. He is a Co-I on the radio and plasma waves experiments on Wind, Ulysses and STEREO.

Recently, Dr Osherovich and Dr Fainberg have shown that the north-south asymmetry of the sun expressed in terms of sunspot number (SSN) extends to the heliosphere by the solar wind parameters, combined in the solar wind quasi-invariant:

$$QI \equiv \frac{B^2/8\pi}{\rho v^2/2} = M_A^{-2}$$

where density ρ , B , v , and M_A (the magnetic Mach number) are measured by spacecraft in the solar wind. Previously, we found that the yearly average of sunspot numbers correlates closely with solar wind quasi-invariant QI (correlation is about 98% for 28 years). For three solar cycles between 1975 and 2005, we have shown (figure below) that the double peak structure in SSN, which is mostly due to the time difference of solar maximum between northern and southern sunspots, is accurately reproduced by QI in the northern and southern heliosphere.

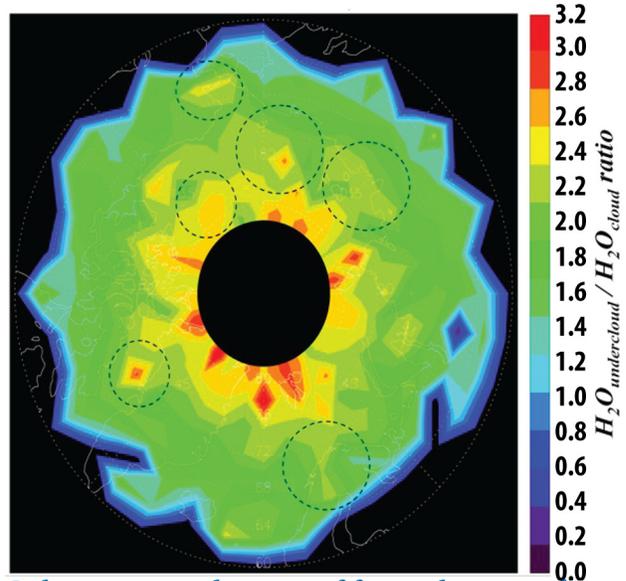


Artem Feofilov



Dr Feofilov is an atmospheric physicist working at GSFC since 2005. Currently, he is affiliated with the Department of Physics of The Catholic University of America (CUA) at GSFC, Code 674. He received his PhD at St Petersburg State University, St Petersburg, Russia, in 2001. He has been conducting research aimed at better understanding the fundamental processes governing the energetics, chemistry, dynamics, and transport of the mesosphere/lower thermosphere. Dr Feofilov is also involved in work dealing with radiative transfer and non-LTE in planetary atmospheres.

In 2010 Dr Feofilov, together with R Goldberg and A Kutepov, continued work on interpreting and analyzing infrared atmospheric emissions measured by the SABER radiometer aboard NASA's TIMED satellite. His main activities in 2010 were: a) validating and analyzing P, T, and H₂O distributions in the current version of SABER data; b) developing the theoretical approaches for processing the radiometric data; c) developing the non-LTE models and retrieval algorithms for interpreting the infrared radiance measurements performed in planetary atmospheres (Mars, Saturn, Titan). The first part included comparing SABER temperatures with falling sphere measurements, validating the $k_{VT}\{\text{CO}_2\text{-O}\}$ quenching rate constant using nearly simultaneous common volume measurements with the Fort Collins lidar, comparing SABER P,T and H₂O VMRs with co-located PMC brightness measurements made by the OSIRIS instruments aboard the Odin satellite and with PMC distributions measured by the CIPS instrument aboard the AIM satellite and using SABER data to study the global temperature distributions during the polar summers of 2002 through 2008. The theoretical part of the work included testing the RQO approach for pumping the O₂(X,v=1) level, the population of which is needed for correct interpretation of H₂O 6.3- μm broadband radiance. It also included providing guidance and advice for developing the methodology of two-channel retrieval of pressure/temperature and CO₂ VMR from the 15 and 4.3- μm channels to be applied in SABER retrievals. Dr Feofilov, together with A. Kutepov, also continued working on interpreting 15- μm CO₂ radiance measured by the MGS/TES bolometer and spectrometer in the Martian atmosphere.



Polar stereographic map of freeze drying and H₂O sublimation effects in Polar Mesospheric clouds revealed in H₂O VMRs. Year: 2007; DOY: 187.

Mei-Ching Fok

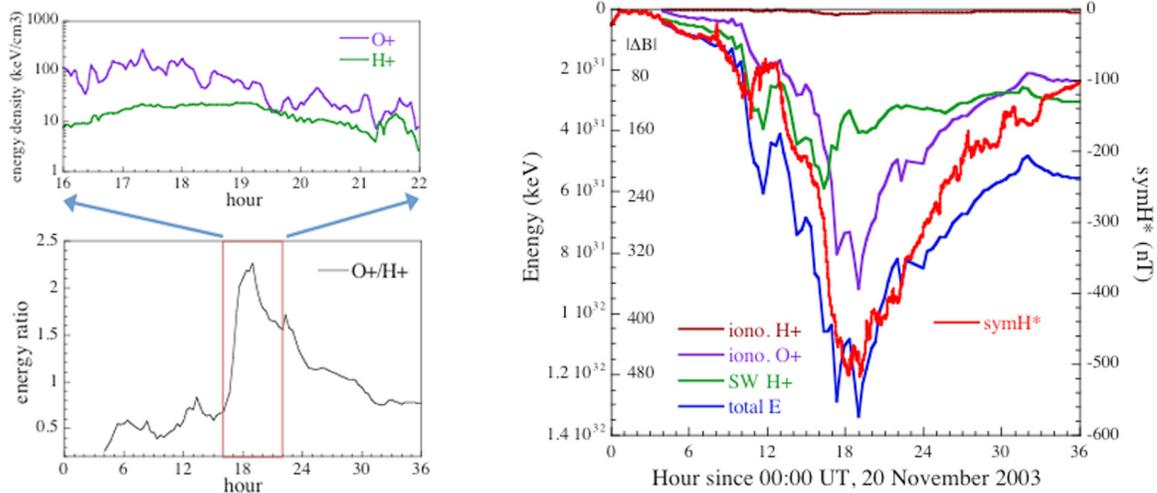


Dr Fok is an astrophysicist with the Geospace Physics Laboratory (Code 673). She received her PhD degree in Atmospheric and Space Sciences in 1993 at the University of Michigan. Dr Fok performed postdoctoral work on ring current and energetic neutral atom (ENA) simulation at the Marshall Space Flight Center before moving to the GSFC in 1997.

Dr Fok continued working on modeling the inner magnetosphere, ionosphere and coupling between plasma populations. She has developed two kinetic models: the Radiation Belt Environment (RBE) model and the Comprehensive Ring Current Model (CRCM). Dr Fok has played an active role in the TWINS mission as the mission's Project Scientist. In addition to handling project-related business,

Dr Fok performed ring current-ENA simulation to help interpret the ENA data and understand the observable features in the ENA images. In collaboration with Dr Thomas Moore (Code 670), Dr Fok simulated the super storm on 20-21 November 2003 to understand how ions originating from the solar wind and ionosphere got access to the magnetosphere and how the subsequent transport and energization processes contributed to the buildup of the ring current.

The simulation reproduced the rapid decrease of Dst during the storm main phase and the fast initial phase of recovery. She found, as expected in the super storms, ring current O^+ is the dominant species over H^+ during the main to mid-recovery phase of the storm. Sub-storm associated magnetic reconfiguration is the major process to accelerate the O^+ ions in the tail and form a seed population for the ring current. The figures below show the calculated energy ratio of ring current O^+ and H^+ , and the contributions from ionospheric and solar wind ions to the total ring current energy content. The simulated magnetic depression has excellent agreement with the observed $symH^*$.



The right panel is the O^+ and H^+ energy density along the CRCM outer boundary during the storm on 2003 Nov 20-21. The left panel is the calculated energy ratio of ring current O^+ and H^+ . The left panel is the simulated ring current ion energy content compared with $symH^$.*

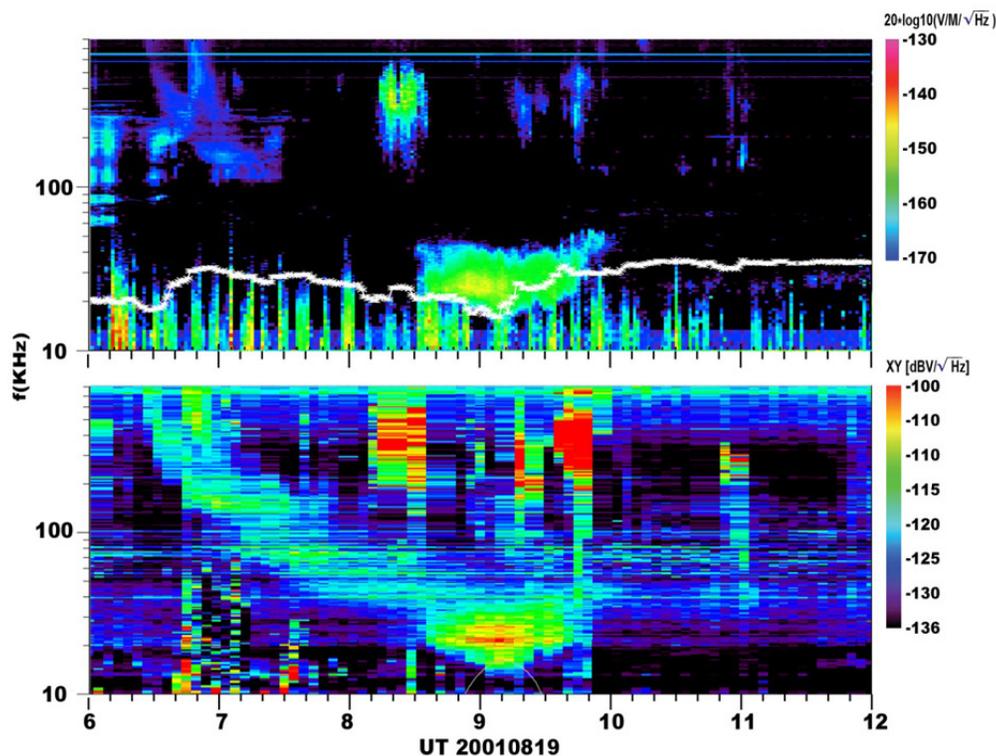
Shing F. Fung



Dr Fung is a space scientist in the Geospace Physics Laboratory (Code 673). He has been a civil servant for over 17 years.

Dr Fung is the PI for the Heliophysics VWO (<http://vwo.nasa.gov>), one of the latest VxOs selected to become a component of the HPDE (<http://hpde.gsfc.nasa.gov>). This, he has led members of the VWO team to work with the SPASE Group Consortium (<http://spase-group.org>) to develop the SPASE data model for describing heliophysics data. Dr Fung was Co-convenor for a VxO special session at the fall AGU meeting held in December 2009.

Dr Fung continues work with collaborators to analyze Cluster data to investigate the role of ULF waves in accelerating relativistic electrons in the inner magnetosphere. As Co-I on a Geospace SR&T project, Dr Fung and co-workers are investigating the direct influence of solar wind and IMF conditions on the ionosphere. He also found an interesting radio emission event. The terrestrial myriametric radio burst (see figure), observed simultaneously by the IMAGE and Geotail spacecraft from nearly diametrically opposite (day-night) sides of the Earth, seems to have had its source in a high-latitude region poleward of the cusp. Since the interplanetary magnetic field was northward at the time, energetic electrons from magnetic reconnection may have been a possible source of the radiation.



A 6-hour data interval showing the start and stop (white lines) of the isolated terrestrial myriametric radio burst (TMRB) observed simultaneously by IMAGE on the dayside at high latitude (lower panel) and Geotail on the night side at low latitude (upper panel).

Holly Gilbert

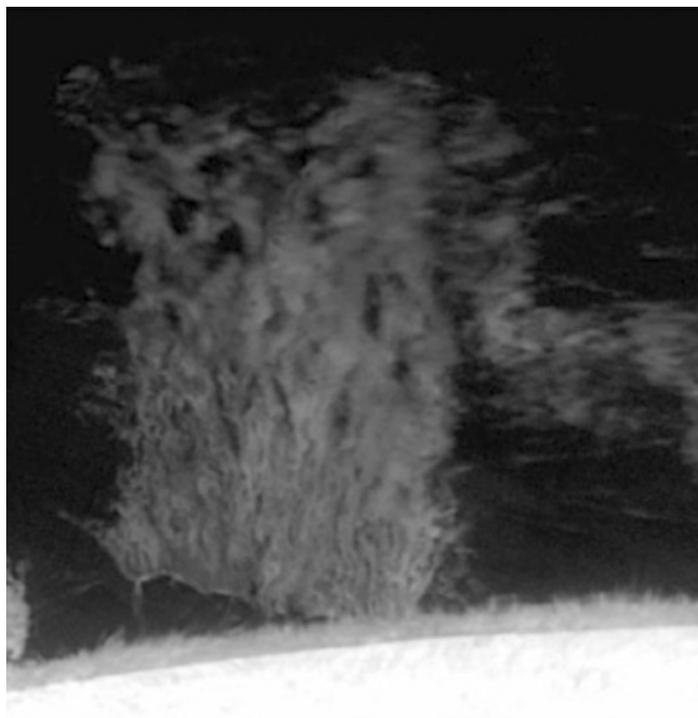


Dr Gilbert joined Code 670 in June 2008 as the Associate Director for Science. Prior to joining the HSD, she was a research scientist at Rice University from 2005–2008, and an associate scientist at the High Altitude Observatory at NCAR from 1998–2005. Dr Gilbert completed her undergraduate work in physics at the University of Colorado and obtained her PhD in theoretical astrophysics from the University of Oslo.

In her role, she manages the Education and Public Outreach (EPO) activities of the Division and assists in the administrative duties involved with running the HSD. She also continues conducting research on solar surface phenomena associated with coronal mass ejections (CMEs). Dr Gilbert supports the Division office as a manager, but also spends a great deal of time participating in outreach activities. These activities span public affairs, including several media appearances (Discovery, National Geographic and History Channels as well as the local news appearances), to “informal education” activities (e.g., presentations at the Visitor Center’s Science on a Sphere). Dr Gilbert serves on several committees/groups at the Center that involve the GSFC Education and Public Affairs Offices, and interacts regularly with potential interns, graduate students, and postdoctoral scientists.

She continues to serve the outside solar community at many levels. Specifically, in 2009 she served as an elected member of the SPD committee, a member of the SPD Hale and Harvey Prize Committee, and a member of the SHINE steering committee.

The primary focus of Dr Gilbert’s research is determining the nature of prominence support, formation and evolution, and how this relates to CMEs. She has conducted detailed studies of the variation in mass of different types of prominences by addressing different mechanisms involved in mass loss. Together with several other HSD scientists and a Co-I from NRL, Dr Gilbert led a proposal effort that was awarded through NASA’s LWS TR&T program to study how ion-neutral coupling affects formation, structure and dynamics of partially ionized prominences.



Prominence shows the complicated fine structure and both horizontal and vertical motions. Observing prominence flows and structure in high-resolution data (both ground and space-based) in combination with modeling will advance our physical understanding of how prominences form and how they are supported.

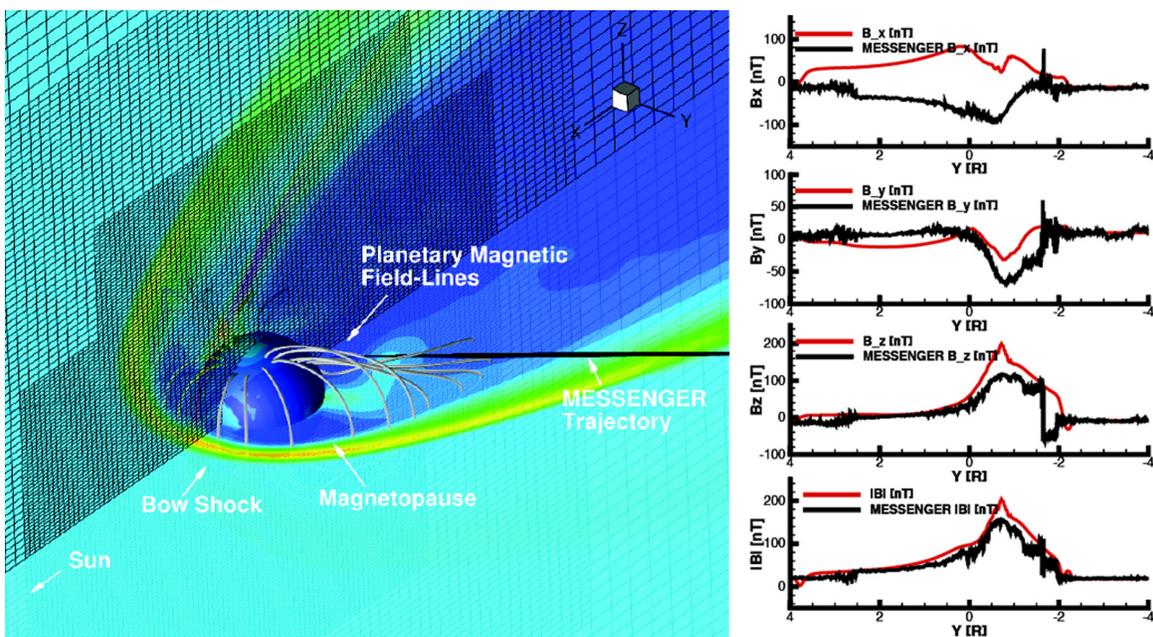
Alex Glocer



Dr Glocer was born in Buenos Aires, Argentina, and grew up in southwest Florida. He obtained his BA in physics and Mathematics from Dartmouth College in Hanover, New Hampshire, and his PhD in space and planetary Physics from the University of Michigan in 2008. He joined GSFC as a NASA Postdoctoral Fellow shortly afterward, and became a civil servant in February of 2010.

Alex's scientific interests encompass several topics from magnetosphere-ionosphere coupling, to inner magnetosphere and radiation belt modeling, to planetary magnetospheres. To study these varied topics, he has both developed new numerical models and coupled together existing models. For example, he developed a new model of ionospheric ion outflow and helped develop a new multi-fluid MHD model of the magnetosphere. These models were then coupled together to explore the consequences of heavy O^+ in the evolution of the magnetosphere during geomagnetic storms. Dr Glocer has further used an MHD magnetosphere model, coupled to a kinetic model of the radiation belts, to explain observed enhancements in the energetic electron population.

Over the last year, Dr Glocer has become increasingly interested in studying planetary magnetospheres. He has used an existing MHD model of Earth's magnetosphere and adapted it to study Mercury during Messenger's flybys and during disturbed conditions. The figure below shows an initial attempt to model the second flyby.



3D MHD simulation of M_Ercury during M_Essenger's second flyby. Shown on the right is a direct comparison of the simulated magnetic field, extracted along the M_Essenger trajectory, and actual M_Essenger MAG data.

Richard A. Goldberg



Dr Goldberg is currently specializing in solar-terrestrial relations. He has flown more than 85 rockets with instrumentation designed to study the middle atmosphere, thermosphere, and ionosphere to learn how this region is affected by radiation and other energy sources both external and from sources closer to the Earth's surface. This has produced more than 140 publications. 2010 was spent concentrating on interpreting data from the SABER instrument aboard the TIMED Satellite. A major breakthrough leading toward the extraction of water vapor from SABER was made and published. Dr Goldberg has worked at GSFC for more than 47 years, for one year as a NAS/NRC Postdoctoral Research Associate, and for the balance as a NASA employee. During 1989-91, he was on leave as at NSF as Program Director of the Solar-Terrestrial Program. He has both a BS degree from Rensselaer Polytechnic Institute and a PhD from Pennsylvania State University in physics.

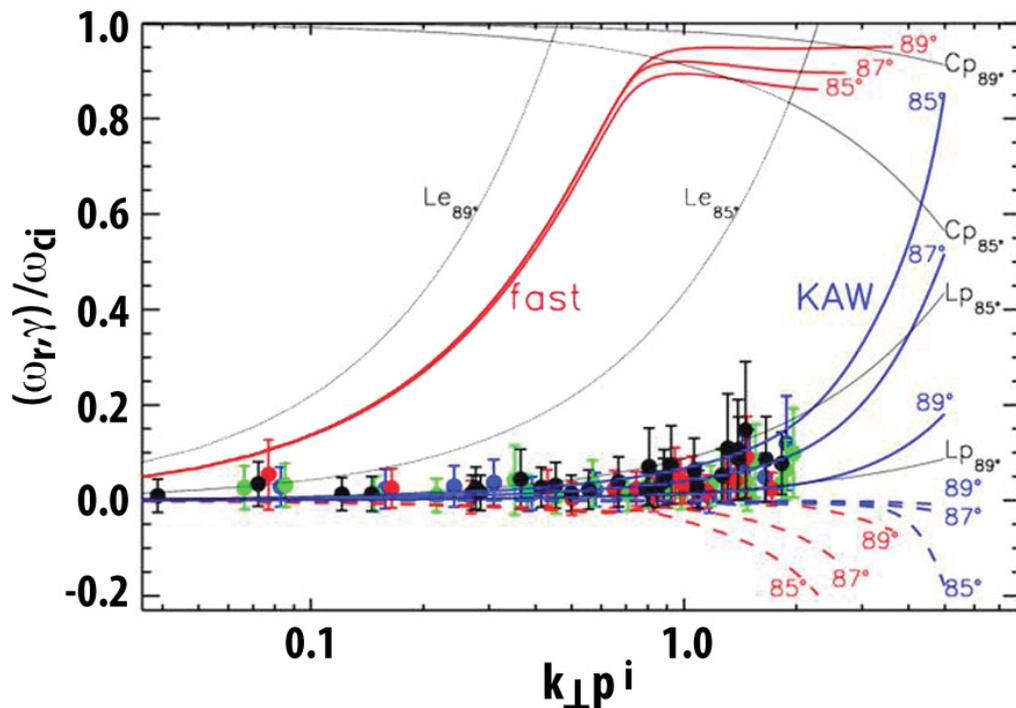
As the GSFC Project Scientist for the TIMED Satellite, and with his activities as a principal investigator for many rocket programs, he has worked with numerous agencies, companies and universities, both nationally and internationally. Dr Goldberg served on various review panels for NASA and other agencies, and been involved on definition teams and study groups for various planning activities. He has also served as adjunct professor with the Electrical Engineering Department at The Pennsylvania State University. From 1990 to 2000, he served as an editor for the Journal of Atmospheric and Solar-Terrestrial Physics.

The mesosphere/lower thermosphere region (MLT) has been a difficult region to analyze and understand, largely because of the difficulty in making in situ measurements there other than with rocket soundings. Yet the MLT is one of rapid change caused by the atmospheric dynamics coupled with numerous sources of highly variable energy sources. Currently, Dr Goldberg is attempting to explain the anomalously warm polar-mesopause region during the summer of 2002 and link the source for this heating to a stratosphere warming in the southern hemisphere by using TIMED/SABER data. He is also trying to compare TIMED/SABER temperature data with other satellite and rocket temperatures, to determine the optimum approach for making and using such comparisons. This year Dr Goldberg has produced one publication and three presentations.

Melvyn Goldstein



Dr Goldstein, Space Plasma Physicist, has been at GSFC since 1972, first as a National Research Council Postdoctoral Associate and, since 1974, as a member of what is now the Geospace Science Laboratory. In 2006, he was elected a Fellow of the American Geophysical Union. His research focuses on a variety of nonlinear plasma processes that can be elucidated using data from the four Cluster spacecraft. In addition, Dr Goldstein has participated in large and complex simulations of the origin of magnetohydrodynamic turbulence in the solar wind. He serves as NASA's Project Scientist for the ESA/NASA Cluster mission and is Principal Investigator of an Interdisciplinary Science grant that supports NASA's Magnetospheric Multiscale Mission.



Observed dispersion relations (dots), with estimated error bars, compared to linear solutions of the Maxwell-Vlasov equations for three observed angles between the magnetic field and wave vectors (the dashed lines are the damping rates). The black curves are the proton and electron Landau resonances, and the curves Cp are the proton cyclotron resonance.

Natchimuthuk Gopalswamy

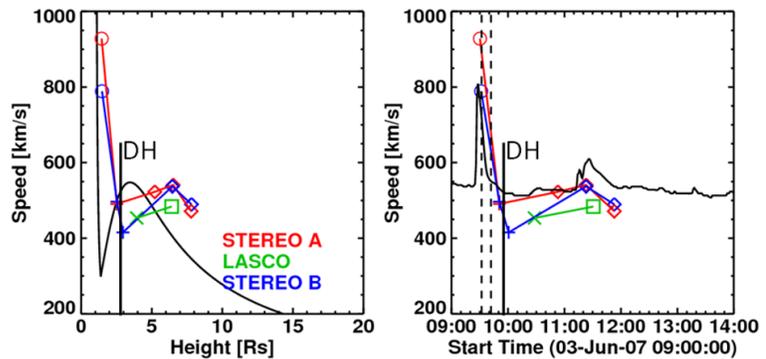


Nat is with the Solar Physics Laboratory. He worked at the University of Maryland, College Park, for 13 years, and 5 years at GSFC as a contractor through the Catholic University of America before becoming a civil servant. Nat's main area of research is large-scale solar disturbances such as coronal mass ejections that have serious consequences in the heliosphere, in particular, geospace.

Shock-driving CMEs have been the main focus of Nat's work during the past year: He analyzed SOHO, STEREO, and Wind data in conjunction with ground-based observations to demonstrate that CME-driven shocks form very close to the Sun (as low as 300,000 km above the solar surface). The shock formation height and the distance over which the shock survives depend on how the CME speed and the Alfvén speed of the ambient medium vary with the distance from the source active region. He continued his work on how CME kinematics organizes the properties of shocks observed at 1 AU. Examining the relation between of complex type III bursts solar energetic particle (SEP) events, he found that the type III burst may not be a good indicator of SEP events.

In FY2010 Nat conducted two Coordinated Data Analysis Workshops (CDAWs): (i) on ground level enhancement (GLE) events and (ii) on the flux rope nature of CMEs. The CDAWs were supported by the Living with a Star program, and several articles are being prepared to publish the results of the CDAWs. He also worked on the concept of an Earth-affecting Solar Causes Observatory (EASCO) that proposes to observe large-scale solar disturbances from the Sun-Earth L5 point.

Nat continues his space weather outreach activities as the international Coordinator of the International Space Weather Initiative (ISWI). He continues to serve as the President of IAU commission 49 (Interplanetary plasma and heliosphere).



(Left) CME (data points) and Alfvén speed profile (black curve) with height. Type II burst ends at decameter hectometric (DH) wavelengths when the CME speed drops to the local Alfvén speed. (Right) CME speed follows the GOES light curve (black curve). Vertical dashed lines mark metric type II interval.

Joe Gurman

Dr Gurman is the United States Project Scientist for SOHO, STEREO Project Scientist, and SDAC Facility Scientist.

Dr Gurman has worked at GSFC since 1979 and for NASA since 1985. He received a BA degree in astronomy from Harvard College in 1972, a MS degree in physics from the University of Colorado in 1974, and a PhD in astrophysics from the University of Colorado in 1979.

In addition to being the United States Project Scientist for SOHO and the STEREO Project Scientist, he leads the local team that operates and disseminates the data from the Extreme ultraviolet Imaging Telescope (EIT) onboard SOHO. He completed three years chairing the Solar and Heliospheric MOWG in January. He is also the AAS Solar Physics Division (SPD) Webmaster, and also just completed three years on the SPD's nominating committee.

In 2010, Dr Gurman led the Senior Review proposal efforts for both STEREO and SOHO and subsequently, both missions were extended for another three years. As facility scientist for the Solar Data Analysis Center (SDAC), he acted as de facto manager for the development of the Virtual Solar Observatory (VSO). The VSO has developed and is now working on the robustness of an international data access network for the Solar Dynamics Observatory (SDO) mission; the SDO AIA and HMI instruments produce well over 2 Tbyte of data per day when decompressed. The network uses the existing VSO internals and the NetDRMS database management software developed for the SDO AIA-HMI Joint Science and Operations Center (JSOC). Major servers are located at the Smithsonian Astrophysical Observatory (SAO) and the National Solar Observatory (NSO), as well as ones in Belgium, France and the United Kingdom. The SDAC also devotes some 60 Tbyte of storage to the SDO data service effort, to cache data requests.

Summary by Month										
Month	Daily Avg				Monthly Totals					
	Hits	Files	Pages	Visits	Sites	KBytes	Visits	Pages	Files	Hits
Oct 2010	25181	25030	25080	968	675	623654774	9682	250803	250301	251810
Sep 2010	24587	22639	24412	737	537	3124531139	22136	732376	679188	737636
Aug 2010	18212	18029	18074	74	970	2909856183	2311	560315	558916	564575
Jul 2010	35045	24574	34920	69	569	3128641317	2147	1082533	761823	1086398
Jun 2010	11090	10922	11022	54	288	1633872634	599	121248	120152	121992
Totals						11420556047	36875	2747275	2370380	2762411

Usage statistics for VSO access to SDO data, through 2010 October 10

James Patrick Haas



Pat is an electronic instrument systems engineer who joined GSFC in 1988; he is responsible for the conceptual and detailed design of numerous instrument controller systems and ground support equipment (GSE) for the Laboratory for Astronomy and Solar Physics and now the Solar Physics Laboratory (Code 671). He designed the Transputer based parallel processing controller for the NIS detector of the Coronal Diagnostic Spectrometer (CDS) on board the SOHO spacecraft, along with a similar system for the Solar EUV Research Telescope and Spectrograph (SERTS) sounding rocket mission. He served as lead electrical and systems engineer during seven SERTS launches and continues to perform that role with its successor instrument the Extreme Ultraviolet Normal Incidence Spectrometer (EUNIS), which is currently being upgraded for its third launch scheduled for spring 2011.

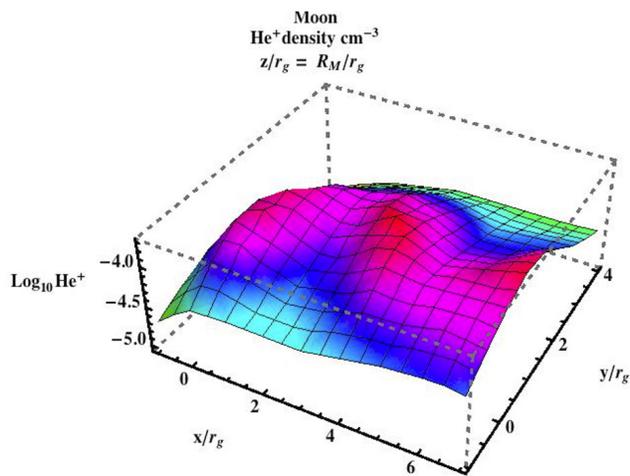
Pat has also developed various advanced detector systems for concept demonstration and ground-based astronomical observations, serving as Co-I on the Random Access Photon-Counting Intensified CID Detector (RACID) and the Event Driven Active-Pixel Sensor development effort (EDAPS). As part of these efforts he developed the first high speed, real-time, event data detection and centroiding system capable of performing on-the-fly centroiding algorithm selection and correction.

Mr. Haas has most recently been involved with the U.S. Air Force Academy in a FalconSAT-7 mission collaboration IRAD that will demonstrate the first space deployment of a photon sieve primary optic onboard a 3U CubeSat.

Richard E. Hartle



Dr Richard E. Hartle is a physicist in the Heliophysics Science Division. He received a BS degree from the University of Michigan and a PhD in physics from Pennsylvania State University, where his major research interest was theoretical plasma physics. In 1964 he joined NASA and worked at the Ames Research Center for three years as an NRC-RRC before transferring to GSFC, where he is still employed. During his career, Dr Hartle has carried out theoretical and experimental research on the solar wind, planetary atmospheres and ionospheres, plasma physics and gas dynamics using measurements made from the instruments on satellites such as the Atmosphere Explorers, Dynamics Explorer, Mariner 10, Voyager, Pioneer Venus, Galileo and Cassini. In addition to his research interests, he has performed as Head of the Planetary Atmospheres Branch, Project Scientist for the Earth Observing System, Assistant Chief of the Laboratory for Atmospheres, and Associate Director of the Joint Center for Earth Systems Technology.



Density of lunar He^+ pickup ions on a plane containing the ion's cycloidal trajectories, where the ion gyroradius exceeds neutral scale height.

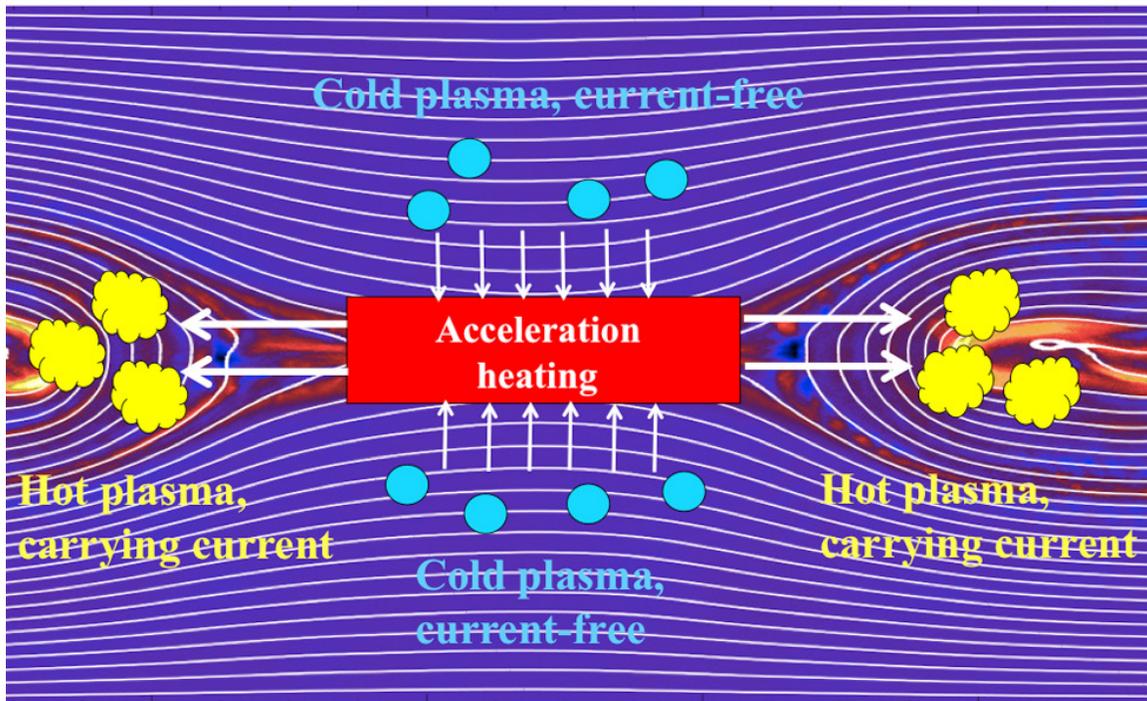
Dr Hartle is currently working on the phase/space distribution of pickup ions from a number of planets and satellites. From the moments of their distributions, several macroscopic parameters are calculated (such as densities, velocities, etc.). For example, lunar He^+ densities are shown in a plane ($z/r_g = -R_M/r_g$, the lunar exobase in units of r_g) containing the pickup ion trajectories, where x/r_g is along its drift direction and y/r_g the background electric field. The image of a cycloidal trajectory is the obvious feature of this view, which continuously repeats along x every $2\pi r_g$ as it $\rightarrow \infty$. The appearance of a cycloidal trajectory is possible primarily because the He^+ gyroradius exceeds the He scale height, making it a kinetic plasma, where the greatest numbers of ions are created around the neutral density peak at the Moon.

Michael Hesse



Dr Hesse, space plasma physicist, is Chief of the Space Weather Laboratory (Code 674) and Director of the Community Coordinated Modeling Center. His research focuses on the development and assessment of Space Weather modeling capabilities, and on basic research of the properties and dynamics of space plasmas. In his role as Lead Co-I for Theory and Modeling for NASA's MMS mission, he develops new theories of magnetic reconnection, and he advises the MMS project on MMS measurement priorities. As Director of the CCMC, he collaborates with governmental, academic and commercial Space Weather interests across the globe. During 2010, Dr Hesse gave seven invited talks on science and Space Weather topics. During the same period, he published six papers in refereed journals.

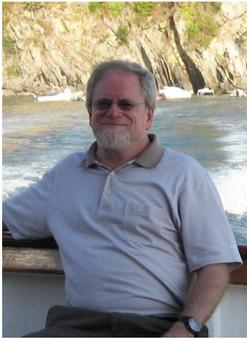
Basic Physics of the Diffusion Region



Reconnection electric field: Acceleration, heating, flux transport

The latest understanding of the physical role of the reconnection electric field. The electric field in the diffusion region serves to maintain the current density. In addition, part of the particle energy obtained from acceleration by the reconnection electric field is thermalized in order to maintain pressure balance across the reconnection layer.

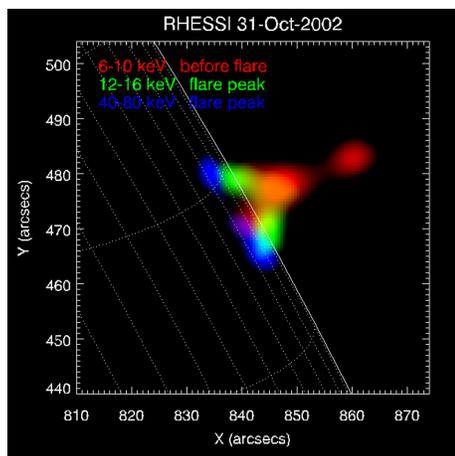
Gordon Holman



Dr Holman is a solar physicist who primarily works on the analysis and interpretation of data from RHESSI. His scientific work largely focuses on obtaining a better understanding of the energy release and particle acceleration in solar flares. He has been an astrophysicist at GSFC since 1985. He received his PhD in astrophysics from the University of North Carolina, Chapel Hill, and a BS degree in physics from Florida State University.

Dr Holman is a Co-investigator on the RHESSI Mission. He leads the RHESSI theory effort at GSFC. He is Principal Investigator on a NASA Heliophysics Guest Investigator grant and Co-investigator on other NASA grants. He served as Chair of the Organizing Committee for the 10th RHESSI Workshop in Annapolis, Maryland (August 2010), and chaired a “Flares and Energetic Particles” session at the AAS/Solar Physics Division Meeting in Miami, Florida (May 2010). He was a member of the Scientific Organizing Committee for the “Energetic Processes in Solar Eruptive Events” sessions at the COSPAR Assembly in Bremen, Germany, and serves as an adviser to the Physics Today book review section. He maintains or helps maintain several Web sites, including the RHESSI Web site and the Solar Flare Theory Educational Web site. He continues to advise graduate student Yang Su from Purple Mountain Observatory in Nanjing, China.

Dr Holman’s research has primarily focused on the physical processes that affect energetic electrons accelerated in solar flares and the X-ray emission they subsequently radiate. He is studying how X-ray images and spectra obtained with RHESSI reveal the evolution of these electrons in flares. He is also studying how the evolution of these electrons relates to the evolution of thermal plasma and magnetic fields in flares. Dr Holman is also currently examining the impact of non-uniform plasma ionization and return-current energy losses on flare hard X-ray spectra while investigating the uncertainties in model parameters determined from multi-parameter fits to RHESSI spectra.



Composite RHESSI image at the peak time of a flare in two X-ray energy bands, and of the pre-flare structure in a third X-ray energy band. The flare image shows the thermal flare loop (green) and nonthermal loop footpoints (blue). The red pre-flare image shows the upper part of the loop and a compact source above the loop top. The orange region is where the red and green sources overlap.

Joseph A. Hourclé



Mr Hourclé was born somewhere other than the security office insists he was born, but would still rather not say as it's still in use as a security question for some NASA systems. He obtained his BS degree in Civil Engineering from The George Washington University and his Master of Information Management from the University of Maryland, College Park. He has worked in the Solar Data Analysis Center at GSFC for six years as a programmer and system administrator. He previously worked for a large university he would prefer not to name (that he left on less than good terms) and an information services contractor you have never heard of, and a small Internet service provider in Frankfort, Kentucky where he helped start the Web site, Fark.com.

At the Solar Data Analysis Center, Joe primarily works on the Virtual Solar Observatory, but has spent these past two years working with other members of the VSO team to adapt the SDO JSOC's DRMS to be used for distribution of AIA and HMI data to caches at other institutions, and from there, distribution to the general public. As part of this effort, he made numerous changes made to the backend logic of the VSO, and a number of enhancements to the IDL client distributed through SolarSoft.

Joe won second place in two competitions this year: the "Your Science as Food" competition for his cake, "The Sun in 4 Filters," and the "SESDA2 Elevator Speech Contest" in which he recommended that people developing data systems or writing data management plans to talk to people who specialize in these topics so we can build better systems and get our data used by more people.



"The Sun in 4 Filters" was awarded second place in the "Your Science as Food" competition.

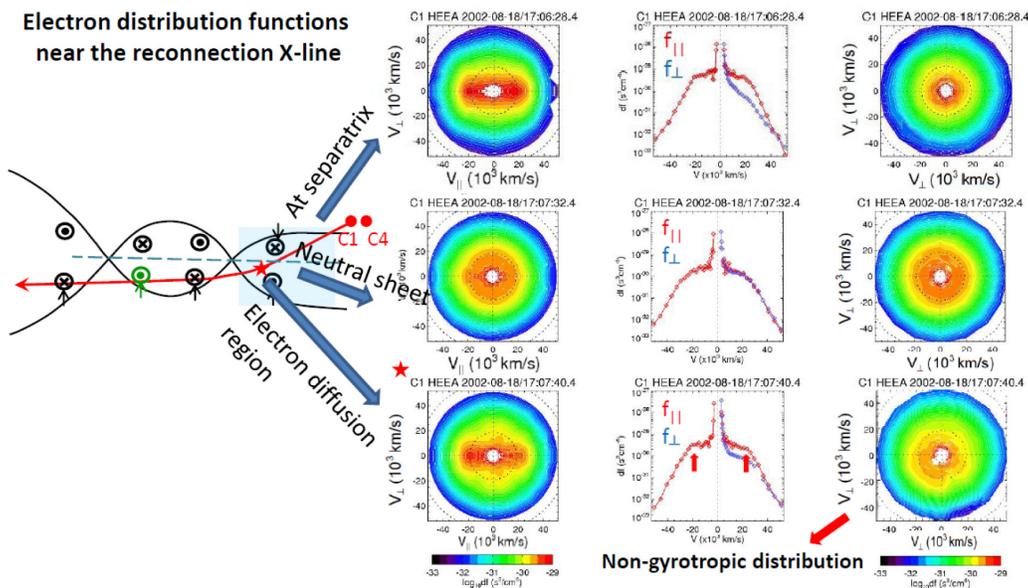
Kyoung-Joo (Joo) Hwang



Dr Hwang joined GSFC in October 2008 as a UMBC/GEST research associate and has been working with Dr Melvyn L. Goldstein. Three main topics of her research are magnetic reconnection in Earth's magnetotail current sheet, surface waves at the Earth's magnetopause (often identified as resulting from a Kelvin-Helmholtz instability) and dipolarization front events in the Earth's plasma sheet, using Cluster data.

She analyzed multiple near-X-line structures in Earth's current magnetotail sheet from Cluster data. She also reported an observation of the electron diffusion region in the reconnection site, which is for the first time from the observational point of view, based on the observations of non-gyrotropic electron distributions accompanied by super-Alfvénic electron outflow jets and enhanced high-energy electron fluxes. The divergence of electron pressure tensor indicated a localized peak during the Cluster's traverse of the electron diffusion region.

She analyzed and reported conjunctive observations of magnetopause fluctuations by Cluster and THEMIS during varying IMF conditions. The comparisons of the two observations suggest the remote (most likely near the subsolar region) generation of the surface waves observed by THEMIS, for variations in the wave properties such as period, wavelength, wave-front steepness and spectral power density according to IMF orientations. She also has investigated the dipolarization front events observed by Cluster near the Earth's central current sheet. These DFs were presumably generated by bursty and/or patch reconnection and occurred tail-ward of Cluster spacecraft as indicated by the associated earthward fast flows. From in-situ observations with help from the MHD/LSK simulations, she suggested the effects of near-Earth tail reconnection properties and the efficiency of the dipolarization front injection on substorms.



Cluster observations of the electron distribution functions near the first X-line of the reconnection site during its traverse of a series of X-line structures. The separatrix region (top 3 panels) is characterized by an anisotropic distribution $T_{\parallel} > T_{\perp}$ and counter-streaming beams. Near the current sheet (middle panels), an isotropic, flattop distribution with an increased temperature is found. The bottom panels show counter-streaming components with a significant deviation from the gyrotropy.

Suzanne Imber

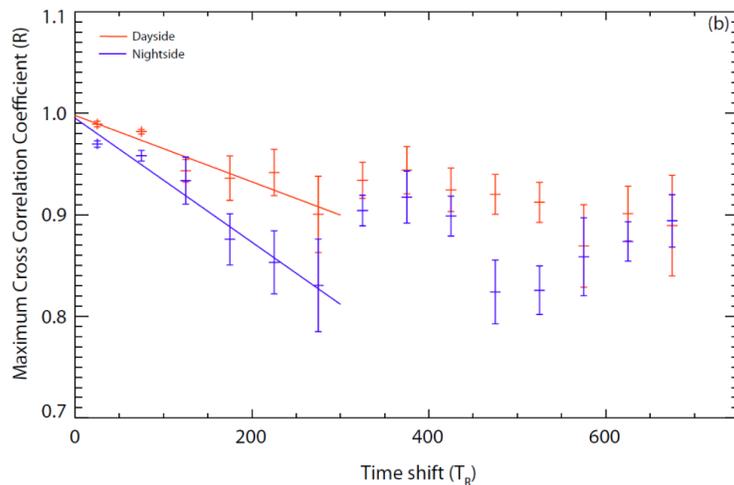


Suzie came to Goddard in October 2008 as part of the UMBC/GEST programme having completed her MSc at Imperial College, London in 2005 followed by her PhD at the University of Leicester in the UK. She primarily works with Dr Jim Slavin studying the dynamics of the magnetotail at Earth but is also interested in Earth's field-aligned current systems and the location and rate of reconnection in the magnetosphere.

The primary focus of my research is to better understand the nature of reconnection in the magnetotail using in situ magnetic field and plasma data. I have primarily been using data from the THEMIS mission, which provides unique multi-point measurements of the near-Earth tail enabling the number of reconnection sites as well as the rate, the location and the spatial extent of the x-lines to be investigated.

I have also been investigating the temporal and spatial variability of the region 1 and 2 field aligned current (FAC) systems at Earth, using data from the Space Technology 5 mission. This mission consisted of three spacecraft in identical low altitude dawn-dusk sun synchronous orbit with separations ranging from tens of seconds to ~10 minutes. Cross correlating the magnetic field signatures of the FACs observed by pairs of spacecraft allows an estimate of changes in the large-scale features of the FACs, as well as enabling a determination of whether the currents have moved poleward or equatorward (i.e., the polar cap has expanded or contracted) between observations. The histogram below shows the results of a statistical study of 389 FAC crossings; R is the maximum cross correlation coefficient between each pair of spacecraft observations, and t is the inter-spacecraft separation time.

Over short timescales R linearly decreases with increasing spacecraft separation, however beyond ~300 seconds the currents appear to stabilise. The dayside currents are more stable than the nightside ones, probably due to a combination of the dayside currents generally having greater amplitude, and the nightside currents being disrupted by substorm activity.



Jack Ireland



Dr Ireland is a scientist working for ADNET Systems, Inc. He has been at GSFC since August 2001. He obtained both his degrees, BS in Mathematics and physics, and PhD in physics, from the University of Glasgow in Scotland. Previously, he worked as a post-doctoral research assistant at the University of St. Andrews in Scotland.

Dr Ireland is PI of the Heliviewer Project, a project to develop Web-based technologies for the browsing dissemination of heterogeneous solar and heliospheric data sets via intuitive interfaces. He was Chair SOC of the Fifth Solar Image Processing Workshop, Les Diablerets, Switzerland.

Dr Ireland's work in 2010 lay in four primary areas:

He helped develop user-friendly interfaces for the exploration of solar datasets, catalogs and science, with application to the challenge of making SDO data easily "browsable." He developed a suite of software that allows anyone with correctly formatted FITS data to make their data available via the Heliviewer Project. He applied Bayesian probability techniques to the understanding of flare spectra from the RHESSI spacecraft, and found that the Markov chain Monte Carlo techniques commonly used in Bayesian analysis problems find parameter values very different from those found by traditional spectral fitting techniques for the same value of reduced chi-squared, indicating that some models are more poorly constrained by the data than previously thought. He has developed an algorithm for the automated detection of oscillating regions in the solar atmosphere, based on Bayesian probability techniques. Dr Ireland expects to continue working in these research areas in the coming year.

Dr Ireland also supervised three students this year. He also won a NASA SR&T award entitled "Investigation of the Low-energy Cutoff in Solar Flares" and a NASA LWS award "Solar Image Processing Workshop V: Solar Image Processing in the Petabyte Era." He also edited a topical issue of Solar Physics on solar image processing techniques.

Sarah L. Jones



Dr Sarah L. Jones was born in Rutland, VT. She obtained her BA degree in physics from Dartmouth College, and her PhD from the University of New Hampshire in 2010. As a graduate research assistant, she worked with Dr Marc Lessard to develop a pair of onboard imagers for the ROPA sounding rocket launched in 2007. Sarah was involved with the SCIFER2, ACES, and CASCADES2 sounding rocket missions, and through a NASA Graduate Student Research Program fellowship she worked for a summer at GSFC with Dr Sigwarth. She became an official GSFC employee in August 2010.

Sarah is publishing an analysis of THEMIS ground camera data for a study related to her doctoral dissertation detailing space- and ground-based measurements of pulsating aurora. THEMIS all-sky imager mosaic movies show a widespread pulsating aurora, which sometimes lasts >10 hours and can extend into the dayside auroral oval. These observations show that the occurrence of a pulsating aurora is not limited to the substorm recovery phase as often has been assumed and that the pulsating aurora results in widespread luminosity corresponding to a significant transfer of power from the magnetosphere to the ionosphere.



De-spun Rocket Borne Imagers flown on Rocket Observations of Pulsating Aurora four-stage sounding rocket launched 2007 February 12 (see picture on right, courtesy of Todd Valentic, SRI International).

Sarah is currently working on instrument development and calibration with Dr Sigwarth and plans to continue her involvement with the sounding rocket program and other sub-orbital science opportunities. Sarah’s research interests include studying the aurora in order to better understand magnetosphere-ionosphere coupling interactions and, in particular, as a means of remote sensing processes occurring within the magnetosphere.

Shaela Jones



Shaela Jones is a graduate student at the University of Maryland, working at GSFC under the supervision of Dr Joseph M. Davila. Originally from Iowa, Shaela obtained her BS degree in physics from the University of Florida and her MS degree in physics from the University of Maryland.

Shaela recently defended her PhD thesis entitled, “Measurements of Coronal Rotation and Small Coronal Ejections Using the STEREO COR1 Coronagraph.” In the thesis, Shaela used tomographic reconstructions of the coronal electron density created by Dr Maxim Kramar to show that the lack of latitudinal dependence in the rotation measurements was not due to the projection of low-latitude coronal features onto higher latitudes in the image plane. Additionally, she performed measurements of the coronal rotation rate using the two STEREO spacecraft in combination, allowing for the first time, short-time-lag measurements of coronal rotation.

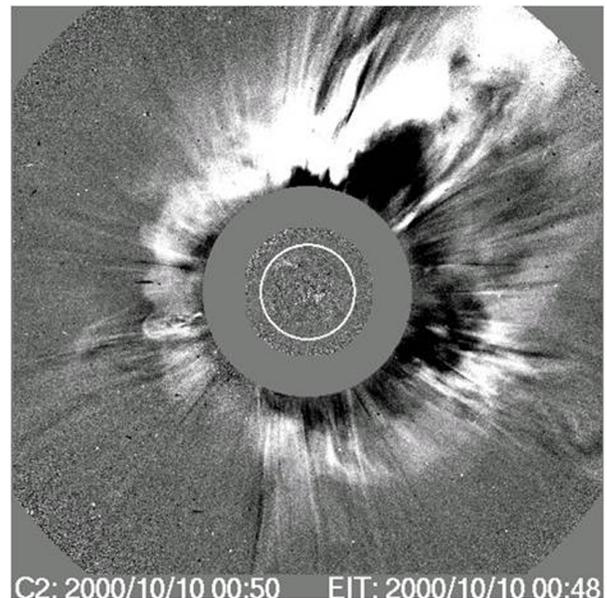
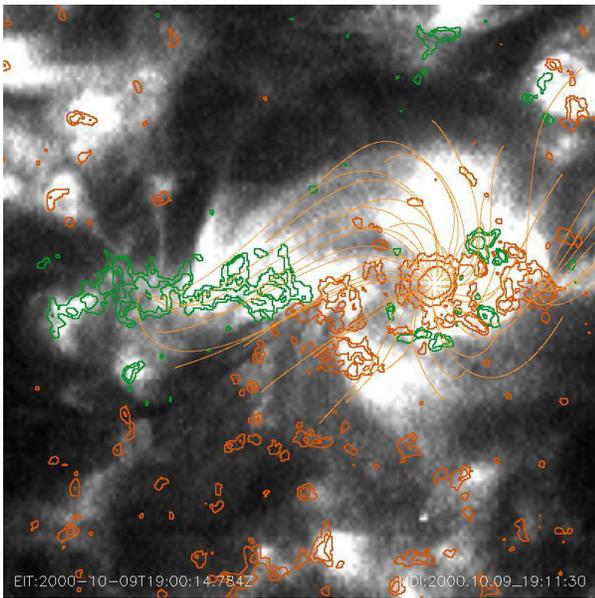
Preliminary results from Shaela’s coronal rotation study were presented on a poster at the fall AGU meeting in December 2009, for which she was awarded an Outstanding Student Paper award. Currently, Shaela is working on extending her rotation measurements to wavelet-enhanced EUVI images provided by Guillermo Stenborg at NRL. She expects to receive her PhD in December and is seeking a postdoctoral position.

Hyewon Jung



Dr Hyewon Jung was born in Nonsan, South Korea. She obtained her BS and MS degrees in astronomy and space science from Chungnam National University, and her PhD from Seoul National University in 2008. After working at Kyung Hee University, Hyewon moved to GSFC in 2009. She is affiliated with the Catholic University of America. She is working with Dr Gopalswamy and his group in Code 671. Hyewon has measured magnetic helicity, the quantitative measure of helical magnetic structure (to understand the energy transfer process from the solar interior to the corona), formation of coronal helical structures seen in filaments and active regions and solar eruptive events.

In 2010, Hyewon studied the quantitative link between coronal mass ejection (CME) speeds and the amount of magnetic helicity in CME source regions (mostly active regions). As shown in the figure above, the magnetic helicity of each CME source region has been obtained by fitting the EUV image (before the CME eruption) from the SOHO/EIT instrument with the modeled helical magnetic field lines. For a sample of 41 CMEs in solar cycle 23, she found that CME source regions of larger magnetic helicity tend to produce CMEs of higher speeds. This result was presented at the 2010 SHINE workshop.

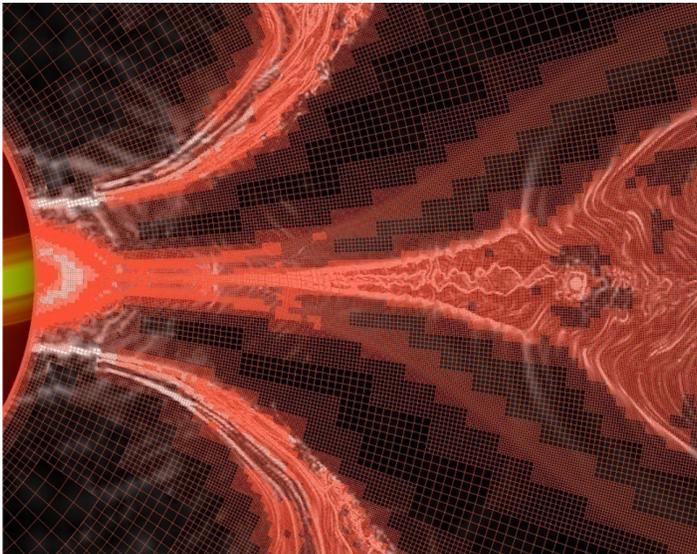


Helical magnetic structure of AR 9182 (left) and the CME from the source region on 2000 October 9 at 23:50 (right). The green and orange contours correspond to negative and positive magnetic polarities.

Judy Karpen



Dr Judy Karpen obtained her BS degree in physics from the University of Michigan in 1974, and her PhD in astronomy from the University of Maryland in 1980. She worked at the Naval Research Laboratory from 1980 to mid-2008 and then joined the HSD Space Weather Laboratory in July 2008. Her research is focused on the fundamental physical processes governing solar and heliospheric activity, such as magnetic reconnection and MHD instabilities. She develops and implements 1D hydrodynamic and 2.5D/3D MHD models of CMEs/eruptive flares, prominences, flux cancellation and jets, to successfully explain and predict observations from NASA space missions and ground-based instruments. Currently, Dr Karpen is a member of the AAS/SPD Prize Committee and the NASA Heliophysics Subcommittee. She has served on numerous NASA, NSF and NAS advisory committees and review panels. She also represents the HSD on the SEMD Women and Minorities Science Forum.



Close-up view of the flare reconnection region at the height of the flare phase ($t=102,500$ s) during a 2.5D MHD simulation of a breakout CME. The image shows the current density (greyscale) and adaptively refined grid (red lines indicate cell boundaries). Post-eruption loops are visible at left, above the equator, while the back of an erupting flux-rope CME is visible at right. The ARMS code, a state-of-the-art 3D MHD code with adaptive regridding developed by C. R. DeVore (NRL), was used for this challenging calculation with 8 levels of refinement.

This past year, Dr Karpen has performed 2.5D MHD simulations of the breakout mechanism for CME initiation, using dynamic adaptive-mesh refinement to obtain very high resolution at current sheets and shocks (see the figure above). She also analyzed 3D MHD breakout simulations to extract estimates of velocity and magnetic fluctuations that will be used as input for existing models of particle acceleration in turbulent regions above and below the flare reconnection site. She is also a member of the LWS TR&T Focused Science Team aimed at developing methods for incorporating effective resistivity due to kinetic processes into MHD models of magnetospheric and solar phenomena. In addition, she has been supervising postdoctoral associate, Dr Manuel Luna Bennasar, in constructing a fully 3D, time-dependent numerical model of a sheared-arcade prominence, using the thermal nonequilibrium mechanism to produce dynamic and stationary cool condensations in the corona.

Shrikanth (Shri) G. Kanekal



Dr Kanekal is a magnetospheric physicist in the Heliospheric Physics Laboratory (Code 672) at GSFC. He joined the laboratory this year. Prior to this, he was employed at the Laboratory for Atmospheric and Space Physics at the University of Colorado, Boulder, from 2004 to 2010. Earlier, he was stationed at GSFC from 1992 to 2000 as a senior scientist employed by Raytheon.

Dr Kanekal's research concerns energization and loss processes of relativistic electrons in the Earth's magnetosphere, solar energetic particles, Jovian electrons, magnetospheric energetic particle boundary dynamics and space weather.

During the recent past (2007 to present) He has been involved in the design and calibration of the REPT (Relativistic Electron Proton Telescope), which is a solid state (SSDs) telescope for measuring electrons and protons in the magnetosphere. The REPT is a key instrument on NASA's RBSP mission (Radiation Belt Storm Probes). He has been involved in refining science objectives and measurement requirements, as well as hardware aspects of REPT. He has developed REPT-specific software to simulate the detector geometry using Geant4. He refined the overall design of the instrument including shielding to reduce background and configuring the SSDs to minimize loss of efficiency due to scattering. He has done studies to determine detection efficiencies, geometry factors and shielding requirements for both protons and electrons. He has participated in the REPT beam test calibration at the University of California, Davis and the Indiana cyclotron facility, both for protons and at the Idaho Electron accelerator facility for electrons.

He has conducted scientific analyses of energetic particle data obtained from SAMPEX since its launch in 1992. He has had a lead role in writing the browse and level-2 data software and participated in calibrating the PET sensor onboard SAMPEX. He has worked on the Polar mission, with the CEPPAD suite of instruments writing and maintaining the key parameter software for the HIST and CAMMICE detectors. He has used energetic electron and proton data from sensors onboard SAMPEX and Polar to study various physical phenomena in the Earth's radiation belts, such as electron energization and loss, trapping of solar protons, access of low energy cosmic rays and space weather.

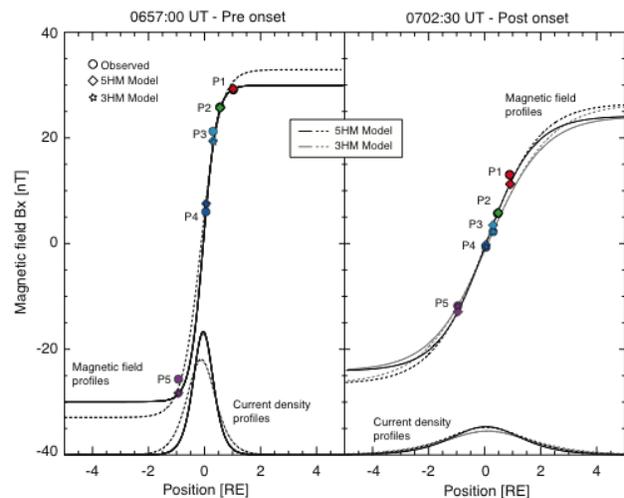
Dr Kanekal has held several NASA grants both as a PI and co-I.

Larry Kepko



Larry Kepko is a magnetospheric scientist who just recently celebrated his first year in the Space Weather Laboratory (Code 674). He completed both his undergraduate and graduate degrees at the University of California at Los Angeles (UCLA), working with Professor Margaret Kivelson on his PhD thesis. He is interested primarily in magnetospheric substorms and the magnetospheric processes that drive the aurora, but retains interest in periodic solar wind number density structures. His current focus is to understand the dynamics of the auroral zone and linkage to magnetospheric processes around the time of substorm onset. In a paper published in *Geophysical Research Letters*, he showed a newly discovered auroral precursor in the 630-nm images prior to white-light auroral onset. This observation fills an important observational gap in understanding substorm models, and indicates that 630.0 nm emissions may be a sensitive indicator of plasmashet dynamics.

During the past year, Larry utilized a fortuitous conjunction of all five THEMIS probes, where the probes were aligned vertically, to study the dynamics of the current sheet in the near-Earth magnetotail during a substorm. Simple Harris modeling using magnetic field data from the five probes shows a thinning of the current sheet (left plot) followed by rapid thickening after substorm onset (right plot), just 5 minutes later. The collapse of the near-Earth current sheet implies “missing” current, which is thought to be diverted into the ionosphere through the substorm current wedge. By comparing the “missing” current inferred from the Harris modeling with magnetic field perturbations on the ground, he was able to calculate the radial extent of the current disruption region. This is the first time such a direct comparison has been made.



Since arriving at GSFC, Larry has worked to enhance the small-satellite capabilities of the Center, leading an informal working group consisting of heliophysics scientists. He also recently became Deputy Project Scientist on THEMIS, assisting David Sibeck. In addition to research, Larry serves in a number of organizations. He is a member of the NSF Geospace Environment Modeling (GEM) steering committee, a GEM Focus Group leader (Modes of Magnetospheric Response), IAGA 2011 Division III.2 Lead Convener (Magnetospheric Substorms and Tail Physics), and chair of the NASA Geospace Management Operations Working Group (G/MOWG). Within GSFC he serves on the Science Director’s Council and is a member of the Scientific Colloquium Committee.

George V. Khazanov



Dr George V. Khazanov obtained his PhD in physics and mathematics from the Irkutsk State University, Irkutsk, Union of Soviet Socialist Republic (USSR). Prior to joining GSFC, Dr Khazanov was Professor of physics at the University of Alaska, Fairbanks. He has extensive experience in space plasma physics and simulation of geophysical plasmas. His specific research areas of expertise include analysis of hot-plasma interactions with the thermal space plasma, with special emphasis on hot plasma instabilities; investigation of current-produced magnetic field effects on current collection by a tether system; space plasma energization and transport; kinetic theory of superthermal electrons in the ionosphere and plasmasphere; hydrodynamic and kinetic theory of space plasma in the presence of wave activity; and theoretical investigation and numerical modeling of ionosphere-plasmasphere interactions and waves and beam-induced plasma instabilities in the ionosphere. Dr Khazanov has supervised three post-doctoral fellows while at NASA's MSFC and GSFC, and has directed more than 30 MS and 15 PhD graduates. He is author or coauthor of six books and more than 250 peer-reviewed publications.

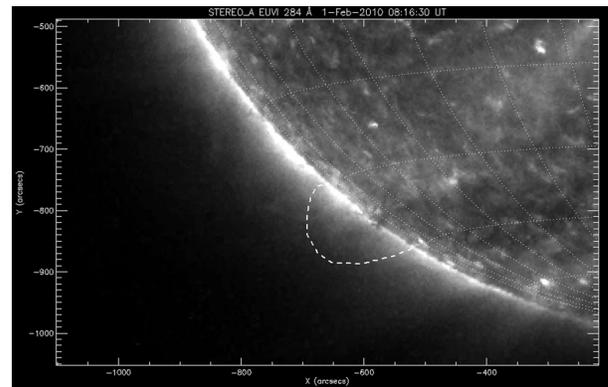
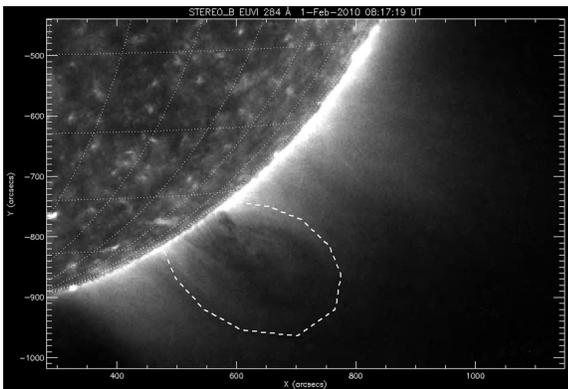
ElectroDynamic (ED) tethers have been investigated for over 20 years, with five NASA missions being flown, and a great deal of practical and scientific knowledge has been gained. Although there has been an excellent history of fundamental research and flight experiments in electrodynamics, additional studies are required to advance ED tether technology. All current and future space assets require propellant to account for drag losses or risk eventual deorbit. This is especially true for important assets, such as human habitats. Additionally, propellant supply is often the dominating factor for asset lifetime in LEO as well as for operational costs. ED tethers have the unique capacity to eliminate the need for major propellant requirements in the future, increase the safety of such assets, and significantly reduce the cost of human presence in space. This technology offers a true revolutionary advantage to the first space exploration realm and would impact the Space Flight Enterprise in all three of its themes, but primarily would benefit the International Space Station. The long-term resupply of reboost propellant will dominate the cost of maintaining the infrastructure and inhibit future expansion (particularly in additional solar arrays and radiator panels). Present-day propellant resupply has enormous safety risks, which is eliminated by ED propulsion. In addition, large space assets, like the Hubble Space Telescope, may be safely and economically disposed of at end-of-life by a small ED tether booster package attached during its last service mission.

Gary K. Kilper



Dr Gary K. Kilper was born and raised near St. Louis, MO. He earned a Bachelor of Arts degree (with Honors) in physics and astrophysics and a BS degree in mathematics from the University of Chicago in 2004, and then completed a MS degree in 2007 and a PhD in astrophysics in 2009 at Rice University in Houston. Gary was in the Graduate Student Research Program through GSFC for three years, and is now in his second year as a NASA Postdoctoral Program fellow at GSFC after arriving in 2009.

In FY2010, Gary continued his research on the eruptions of solar prominences from the corona out into the heliosphere. This involved the combined analysis of data from several different observatories, including the Mauna Loa Solar Observatory on Earth, and the SOHO, STEREO, and Hinode spacecraft. An analysis of the magnetic field near erupting prominences found a correlation between increased plasma motions and photospheric flux cancellation. Further study confirmed this result, and the additional viewpoints provided by STEREO showed that simultaneously, the cavity surrounding the prominence material grows largest where the prominence eruption first starts.



Comparison of STEREO A and B SECCHI/EUVI 284 Å observations from 2010 February 1 of a pre-eruption prominence, whose dark surrounding cavity is far larger around the middle of the prominence (where the eruption starts; right panel) than at the eastern end (left panel).

These results were presented in a seminar at GSFC and at four meetings in FY2010: Fall AGU, STEREO Working Group, AAS Solar Physics Division, and the SHINE Workshop.

Gary has also been working with a few GSFC coworkers to develop a software package for space-themed video games to increase public interest in space exploration. These modifications include special and general relativity, realistic conditions in space and on planets/moons/asteroids, and the use of feasible future technology for propulsion, energy generation, and other aspects of space colonization.

Joseph King



Dr King supports efforts in heliospheric data accessibility and related information management.

Prior to his 2003 retirement from NASA and his becoming a part-time support contractor, he was the Head of the National Space Science Data Center, the IMP 8 Project Scientist, the creator of the 1963-current compilation of solar wind magnetic field and plasma data called OMNI, and the author or coauthor of several papers on the solar wind and its interaction with the magnetosphere.

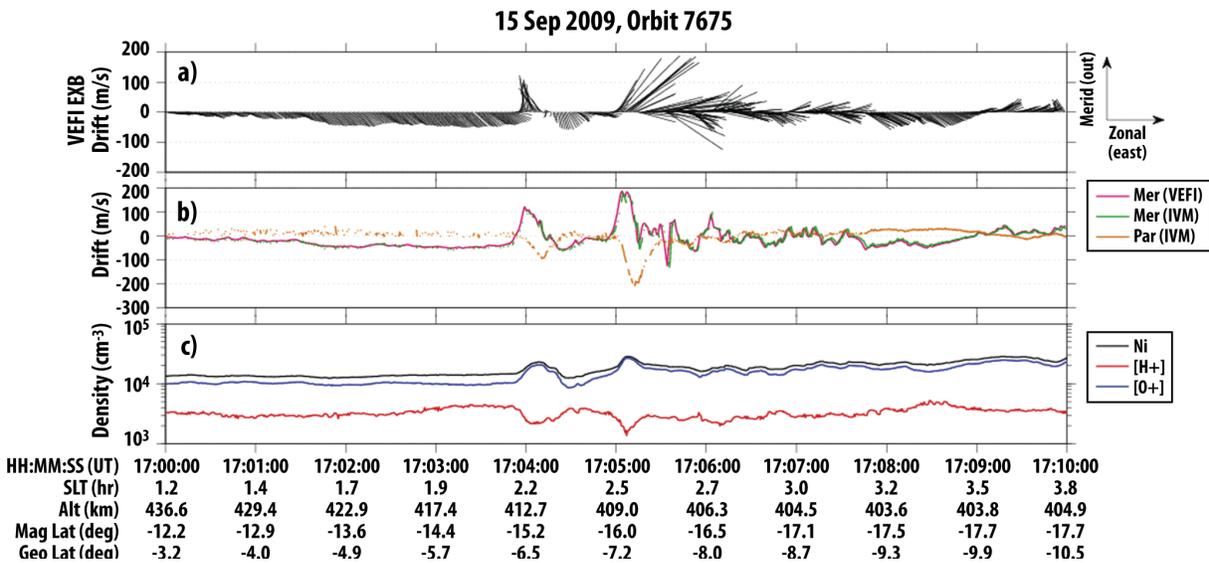
Over the past year, he has contributed to the evolution of the SPASE (Space Physics Archive Search and Extract) data model and has created SPASE-compliant descriptors of many data sets for the Virtual Energetic Particle Observatory and for the Virtual Space Physics Observatory. He is currently working with Principal Investigator teams on apparent discrepancies between Wind/SWE and ACE/SWEPAM α particle to proton density ratios in order to make the OMNI data set yet more reliable.

Jeff Klenzing



Dr Klenzing is an NPP postdoctoral fellow funded through ORAU and has been working in the Space Weather Lab (Code 674) since May 2009. He completed his PhD in physics at the University of Texas at Dallas, where he worked on spacecraft instrumentation for the measurement of thermal plasmas and neutral winds.

He is currently working with Dr Pfaff and Dr Rowland using the C/NOFS data set to study equatorial plasma irregularities. His work combines the electric field data from GSFC's Vector Electric Field Instrument (VEFI) and the plasma particle data from the UT Dallas Ion Velocity Meter (IVM). He has also been working with Dr Seker to compare the C/NOFS measurements of MSTIDs with the Penn State All-Sky Imager at Arecibo Observatory.



Plasma irregularities as observed by the C/NOFS satellite

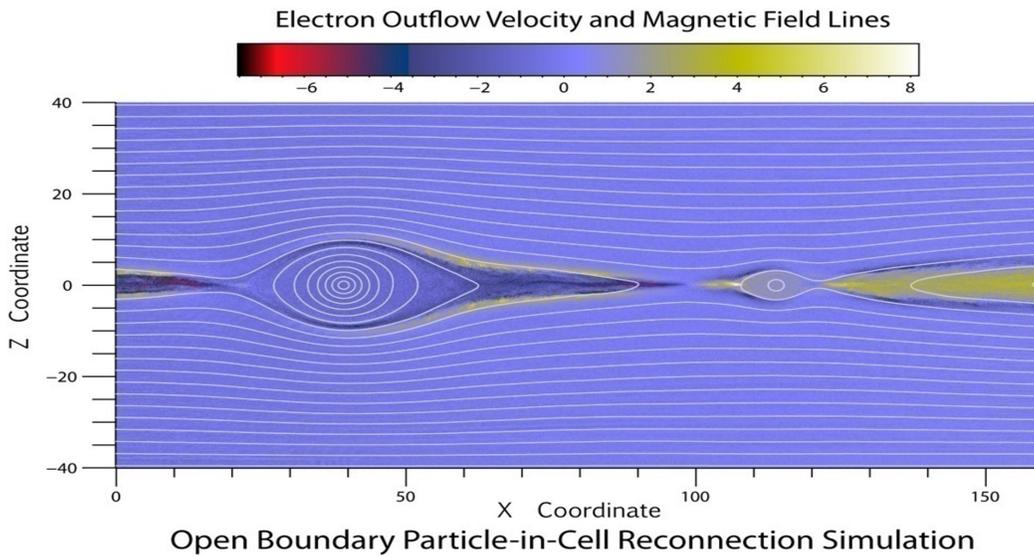
Additionally, Dr Klenzing is working on the development of a gamma ray detector for the Firefly CubeSat. He is also responsible for the Langmuir probes for several future rocket launches.

In early 2010, Dr Klenzing served on the organizing committee for the first C/NOFS science workshop, held in Breckenridge, CO.

Alex Klimas



Alex holds an Emeritus position in HSD and is a faculty member of the GEST program at the University of Maryland, Baltimore County. His research interests are diverse. He remains actively engaged in a study of the system dynamics of the turbulent plasma of Earth’s magnetotail, its relation to the statistics of auroral emissions, and its role in Earth’s substorm cycle. Recently, he has joined a group in the HSD that is studying various aspects of magnetic reconnection in preparation for the upcoming MMS mission.



Well-developed reconnection snapshot. Open-boundary simulation evolves to equilibrium between driven inflow and free outflow for long times. A typical configuration containing multiple active reconnection sites and magnetic islands with freely exiting outflow jets is shown.

His focus there has been on the development and application of open boundary particle-in-cell simulations with the goal of extending the simulations in time beyond the initial transients that have been achievable with closed boundary techniques. In the 1980’s, Alex solved a long-standing problem, the development of velocity space filamentation in Vlasov plasma simulations. His solution, however, was highly specialized and of limited applicability. At present, he is actively collaborating in an attempt to extend this result with the goal of making the Vlasov simulation technique a useful tool for kinetic plasma studies. During FY2009, Alex authored or co-authored eight papers published in refereed journals.

James A. Klimchuk

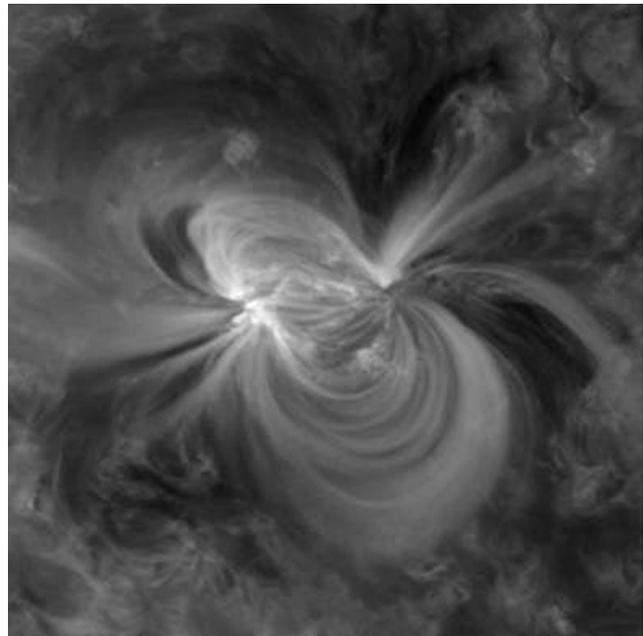


Dr Klimchuk has been an astrophysicist in the Solar Physics Lab at GSFC for almost 3 years, after having spent 14 years at the Naval Research Lab and 7 years at Stanford University before that. He received a BA from Kalamazoo College and a PhD from the University of Colorado.

Dr Klimchuk has served on many panels and committees for NASA and NSF and has held several leadership positions in professional organizations. During 2010, he was Vice-President of IAU Division 2 (Sun and Heliosphere), President-Elect (V-P) of the Space Physics and Aeronomy Section of the AGU, Chair of the NASA Solar and Heliospheric MOWG, Chair of the Coronal Loops Workshop Series Steering

Committee, member of the AAS Committee on Astronomy and Public Policy, and member of the Editorial Board of the journal *Solar Physics*. Dr Klimchuk is a former Chair of the AAS Solar Physics Division and an Honorary Fellow of the Royal Astronomical Society.

Dr Klimchuk's research during 2010 was mostly concerned with the heating and thermal structure of the solar corona, especially coronal loops. He used a combination of observations and numerical simulations to study the properties of the heating and to infer the underlying physical mechanism. His analysis of imaging data from the AIA telescope suite on SDO and spectroscopic data from the EIS instrument on Hinode provided further evidence that coronal heating takes the form of small impulsive energy bursts called nanoflares. Modeling revealed that nanoflares are likely due to the secondary instability of current sheets, not classical turbulence, and that thermal nonequilibrium does not play a major role. Dr Klimchuk gave 5 invited and 3 contributed talks over the course of the year. He authored or coauthored 5 published papers and 2 that are in press.



Solar active region observed by SDO showing loops heated by nanoflares

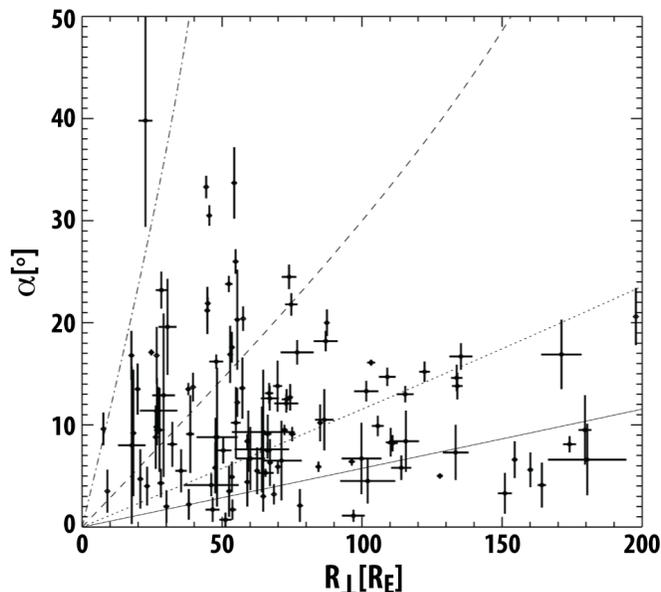
Andriy Koval



Dr Andriy Koval was born in Sumy, Ukraine. He obtained his BSc and MSc degrees from Sumy State University (Ukraine) and his PhD from Charles University in Prague (Czech Republic) in 2006. From 2006 till 2009, he was a fellow at the NASA postdoctoral program at GSFC. Since 2009, he has been working as an assistant research scientist at Goddard Earth Sciences and Technology Center (GEST) at UMBC.

During FY2010, Andriy worked on analyzing the global properties of interplanetary shocks derived from multi-spacecraft observations. His results demonstrate complex shapes of interplanetary shocks and high corrugation of interplanetary shocks on small scales. He attended Fall AGU Meeting in San Francisco and EGU General Assembly in Vienna to give poster presentations on the results, which are also published in a paper.

Andriy has also developed an improved calibration technique for the WIND spacecraft Magnetic Field Investigation (MFI) to allow producing 11(22) vector/sec high-time-resolution data. The improved technique results in a significantly decreased spin noise in the data as compared to the original calibration technique. The high-resolution data are intended for producing the turbulent spectra of magnetic fluctuations which will allow analyzing of both the inertial and dissipation ranges. He is currently producing the high-time-resolution data and magnetic field fluctuation spectra by using the new technique.



Shock-normal differences between Wind and other spacecraft as a function of distance perpendicular to the Wind local shock normal. Solid, dotted, dashed, and dot-dashed lines indicate the model normal differences corresponding to shock curvatures of 1000, 500, 200, and 50 R_E respectively.

Therese A. Kucera



Terry is a solar physicist who joined Code 671 as an NRC post- doctoral fellow in 1993–1995, and then worked in the branch as a contractor until 2001 when she became a civil servant. She received her BA in physics from Carleton College and MS and PhD in astrophysical, planetary, and atmospheric sciences from the University of Colorado, Boulder. She has served as the Deputy Project Scientist for SOHO and STEREO and as STEREO E/PO lead.

Her research area is the solar atmosphere with special emphasis on solar prominences and their EUV emissions. Recently she has also been studying prominence cavities and is a member of the International Space Science Institute's Prominence Cavity Team.

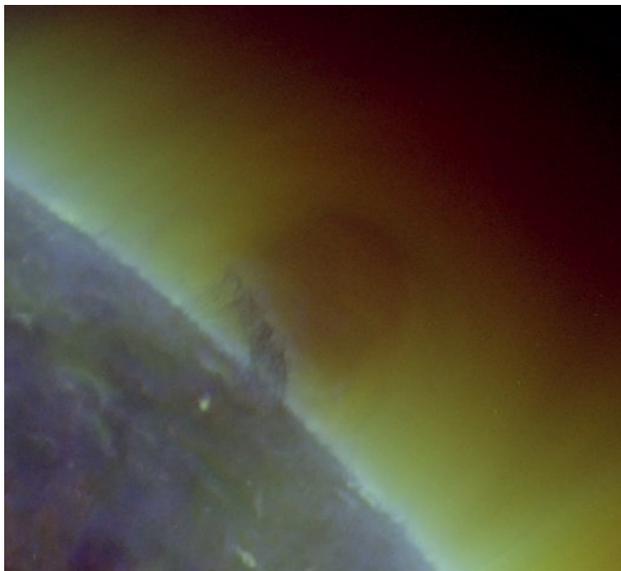


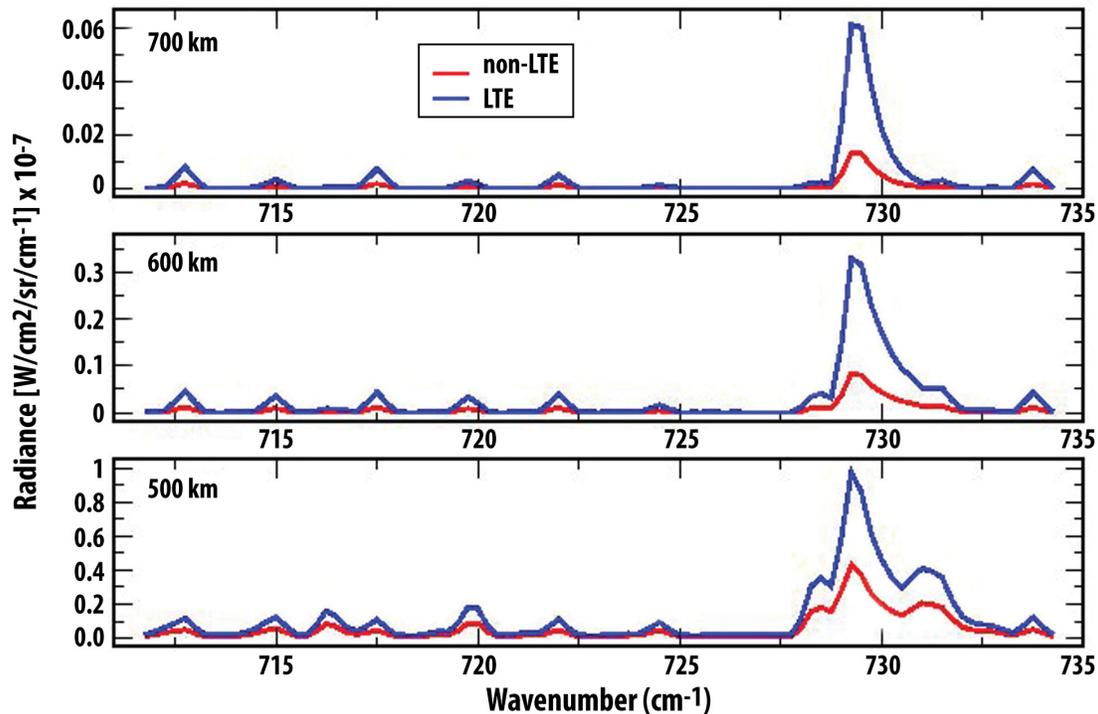
Image of a prominence and cavity from SDO/AIA 2010 July 11 incorporating data from the 211-, 193-, and 171-A bands.

Alexander Kutepov



Dr Kutepov is an atmospheric physicist, PhD in physics (Candidate of Sciences) at the Leningrad State University, currently senior research associate at the Department of Physics of The Catholic University of America (CUA), working at GSFC, Code 674, since 2003.

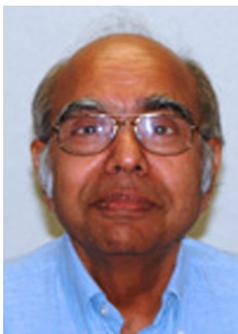
In FY2010 A. Kutepov worked together with A. Feofilov (CUA/GSFC), R. Goldberg (GSFC), and L. Rezac (Hampton University) on the development of the non-LTE two-channel retrieval algorithm and its application to retrieving pressures, temperatures, and CO₂ densities in the Earth's MLT from IR broadband TIMED/SABER observations of the Earth's limb emissions. In this work the first altitude/latitude/seasonal distributions of CO₂ densities from SABER data were obtained. He also continued working together with M. Smith at GSFC and A. Feofilov on the non-LTE analysis of limb observations of the Martian atmosphere by the MGS/TES aimed at retrieving pressures and temperatures in the middle and upper Martian atmosphere above 60 km.



*Estimating the non-LTE effects for CIRS/Cassini
C₂H₂ spectra at tangent heights of 500, 600, and 700 km.*

Together with N. Conor, B. Hesman (both at GSFC) and A. Feofilov A. Kutepov also started working on estimating non-LTE impacts on the Cassini/CIRS IR limb observations of Titan's and Saturn's atmospheres and on developing the non-LTE models for hydrocarbon and nitrile emissions.

Nand Lal



Dr Lal is a member of the Voyager Cosmic Ray Subsystem (CRS) team. He is also a member of the Virtual Energetic Particle Observatory (VEPO) team. He serves as the Technical Officer for Applied Information Systems Program grants. He is also the Division Computer Security Official. He received his MSc physics degree from the University of Delhi, and a PhD in theoretical physics from Cornell University.

He came to GSFC in 1972. His work here has involved design and development of data processing and analysis systems for cosmic ray, γ -ray and X-ray experiments, as well as management and support of information technology programs.

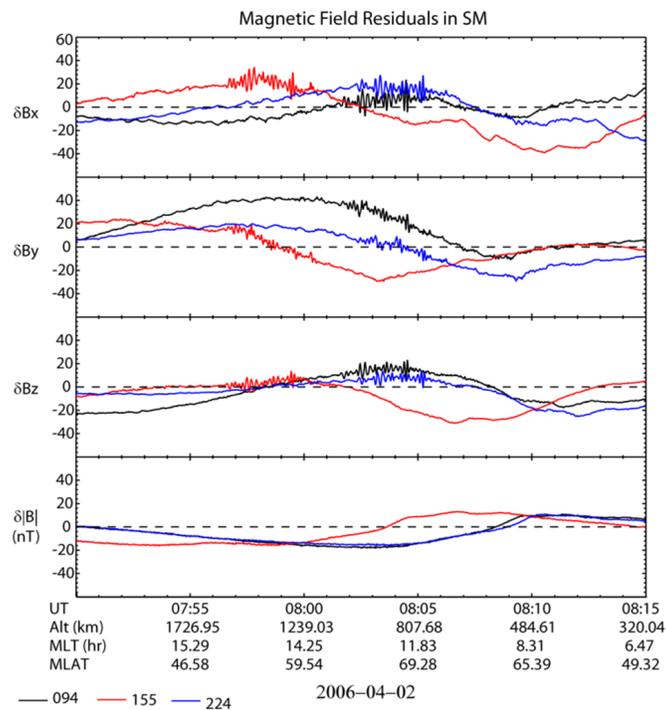
Both Voyager spacecraft are now in the heliosheath. Voyager 1 (V1) crossed the solar wind termination shock (TS) on 16 December 2004, and Voyager 2 (V2) crossed it several times on 30-31 August 2007. The CRS team has been studying the different particle populations (termination shock particles at the lowest energies, the anomalous cosmic rays [ACRs] at mid energies, and the galactic cosmic rays at the highest energies) observed by CRS as the two Voyager spacecraft traverse the heliosheath. The team has reported on these observations at the AGU meetings, in the International Cosmic Ray Conference and the Institute of Geophysics and Planetary Physics (IGPP) as well as in journal publications.

We have been actively involved in the VEPO efforts to improve usability of energetic particle observations by the broader science community. In addition to preparing several new datasets and their descriptions in the common SPASE format, we have developed a prototype for interactively browsing related energetic-particle data products.

Guan Le



Guan is a magnetospheric physicist in the Space Weather Laboratory (code 674). She is the science lead for the Space Technology 5 (ST5) mission, and her research is focused on the study of ULF waves and field-aligned currents by using multipoints magnetic field measurements from ST5. She is a science co-investigator of the Vector Electric Field Instrument on the C/NOFS mission, focusing on the study of ionospheric currents by using the C/NOFS magnetic field data. She is a detailee in NASA HQ Heliophysics Division in SMD. She is the Deputy Project Scientist for MMS and Project Scientist for Geotail. She is a member of AGU Space Physics and Aeronomy (SPA) Section executive committee and serves as the editor of SPA Website and co-editor of SPA Newsletter.



Multipoint observations of a unique type of ULF waves by the Space Technology 5 (ST-5) spacecraft. Whenever the spacecraft traverses across the dayside closed-field-line region at subauroral latitudes, researchers frequently observe strong transverse oscillations at 30–200 mHz, or in the Pc 2-3 frequency range. Our study suggests that these unique Pc 2-3 waves seen by ST-5 are in fact the Doppler-shifted Pc 4-5 waves as a result of rapid traverse of the spacecraft across the resonant field lines azimuthally at low altitudes, revealing the azimuthal characteristics of field-aligned resonances.

Elaine Lewis



Elaine Lewis was born in Baltimore. She attended the University of Maryland Baltimore County for her undergraduate degree and received a Masters in Curriculum Development/Instruction and a second Masters in Administration and Supervision from Loyola College. She taught in Prince George's County Public Schools until 1996, when she joined the GSFC Education Office as a Teacher-On-Loan. In 2000 she became an Education Specialist for the Sun-Earth Connection Education Forum. She initiated Sun-Earth Day in 2000 and co-authored the Space Weather Action Center.

Elaine began 2010 as the lead for Sun-Earth Day-Magnetic Storms and the formal education coordinator. Sun-Earth Day is comprised of a series of programs and events that occur throughout the year culminating with a celebration on or near the Spring Equinox. For Sun-Earth Day 2010, we took a journey into the heart of the electromagnetic force and demonstrated how magnetism, an everyday force that makes motors work, sticks notes to our refrigerators, and keeps electricity flowing to our houses also plays a key role in our understanding of the Sun and is responsible for the most violent explosions in the solar system - magnetic storms! Everyone knows that no Spring Equinox is complete without enjoying the culmination of the NASA Sun-Earth Day Team's year long thematic study and celebration of the heliosphere. This year's theme: magnetic storms. And the Magnetic Storm experts joined NASA EDGE on the set during our live, near 'magnetospherence' free webcast from the National Science Teachers Association Conference in Philadelphia. We even witnessed a cool demonstration of magnetospherence and our magnetosphere by some visiting science teachers.

Elaine led the team efforts for the fourth revision of the Space Weather Media Viewer to now include the data from SDO and new videos including a section on the Heliosphere featuring the Voyager and IBEX satellites.



Blair and Holly Gilbert discuss Magnetic Storms. Credit: Set Therapist

David L. Linard II



Dave is a Senior Aeronautical Engineering Tech in the Solar Physics Laboratory (Code 671) with 35 years of experience in sounding rockets, from the liquid-fuel Aerobee to the Black Brant and Aries Rockets, as well as numerous shuttle payloads: the Get Away Special Program (GAS cans), Spartan 101, 200's, 300's, and 400's, and the Ultraviolet Imaging Telescope (UIT) on Astro 1 and 2.

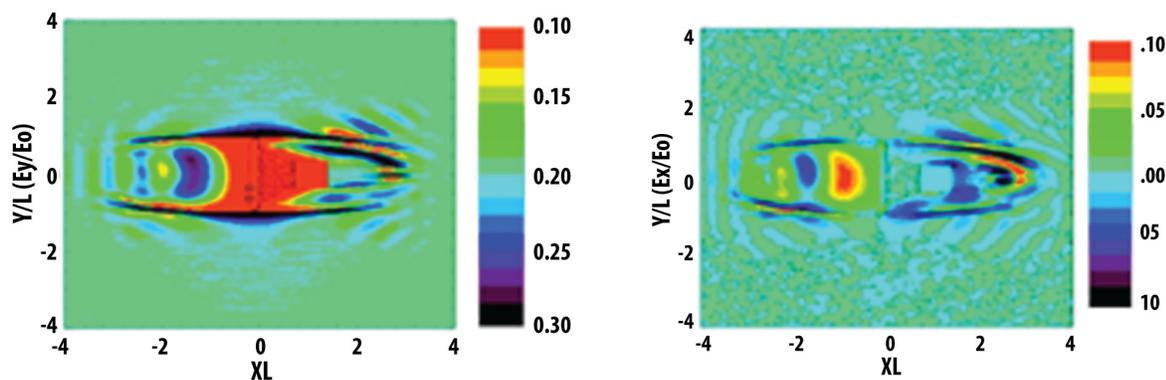
He is currently working on engineering and design for the EUNIS sounding rocket payload: a cooling system for the active pixel sensor detectors to greatly improve signal to noise for the next flight, mechanical stiffening for even better in-flight alignment, and ground support facilities for pre- and post-flight calibrations, as well as design work for the SPICE instrument on the Solar Orbiter mission.

Alexander S. Lipatov



Alexander S. Lipatov born in Moscow, Russia. He obtained his Engineer-Physicist (MS, 1969) and C.Sc. (PhD, 1972) from Faculty of Aerophysics and Applied Mathematics, Moscow Institute of Physics and Technology. In 1988 he obtained his DSc degree from Space Research Institute (IKI) Russian Academy of Sciences. He worked in IKI for more than 24 years, starting as research scientist and finishing as Professor/Lead Scientist. He also worked for more than 23 year as Professor at the Faculty of Problems of Physics and Power Engineering, Moscow Institute of Physics and Technology. His research in collaboration with Profs. Roald Z. Sagdeev, Albert A. Galeev, Lev M. Zelenyi, Vitaly D. Shapiro, and Valentin I. Shevchenko included a global hybrid–drift-kinetic–multifluid multiscale simulation of the interaction of the solar wind with magnetosphere of the Earth, Moon, Venus, comets and extra-solar planets. He had also performed a hybrid/fully kinetic simulation of wave-particle interactions plasma at the front of collisionless shock, in the plasma systems with reversed magnetic field configuration, and the collapse of Langmuir waves (plasmons) in the magnetic field.

He worked for more than three years as a Senior Scientist at GEST UMBC (673) in a collaboration with Drs. E.C. Sittler, J. F. Cooper and R. E. Hartle and his duty was to generate a 3D hybrid-kinetic simulation of the plasma environment near Titan, Europa, and the Solar Probe Plus. As result of collaboration with the Software Integration and Visualization Office (GSFC, 610.3) his 3D hybrid/boltzmann code was converted to the hybrid MPI/OpenMP environment to achieve improved scalability for longer computations on massively parallel computer systems. His hobby includes development of the particle-mesh version of the Complex Particle Kinetics models. These models will allow us to reduce computational resources by a factor of 100 to 1000 in the study of the plasma systems with nonstationary interfaces between the regions with fluid and kinetic (particle wave interactions) dynamics. Examples of the CPK application are the solar flares, collisionless shocks, magnetic field reconnection, magnetosphere of planets, comets, moons, laser produced plasma etc.



Excitation of strong electromagnetic perturbations in the solar wind by the Solar Probe Plus in the inner heliosphere $E_0 = (0.3 - 1.2)$ V/m. The jumps in the polarization electric field are 18–70 V/m in the plasma wake wing behind the bus.

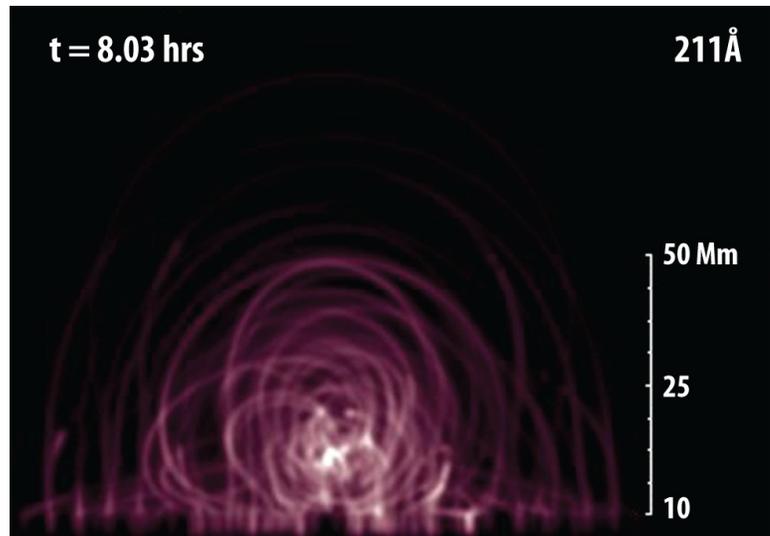
Manuel Luna Bennasar



Dr Luna Bennasar is a solar physicist who received his PhD in physics from the University of Balearic Island, Spain, in 2009. He joined Code 674 at GSFC in September 2009. He has been conducting numerical investigations of solar prominences and coronal heating with Dr Karpen.

Dr Luna Bennasar has considered the 3D magnetic structure of the double-sheared arcade filament channel model, and has evolved understanding of plasma inside a bundle of multiple flux tubes. He uses the results of these simulations and the temperature response functions of different instruments in selected spectral lines to synthesize pictures of the entire 3D prominence structure. Dr Luna Bennasar has concentrated on the Atmospheric Imaging Assembly onboard SDO satellite. Now, we are able to compare our results with the observational data.

Off-limb synthesized image of the model prominence obtained from thermal nonequilibrium simulations, and temperature response of the AIA/SDO 211Å emission line. The LOS is parallel to the prominence filament channel edge.



Peter MacNeice



Dr Peter MacNeice was born in Dublin, Ireland. He obtained his BA in theoretical physics from Trinity College Dublin, and his PhD from the University of Cambridge. He spent four years working for the Rutherford Appleton Laboratory (RAL) in England, commuting between RAL and GSFC to plan and implement observations with the Solar Maximum Mission. He moved to GSFC on a National Research Council fellowship in 1987 and has been here ever since. Peter started as a contractor with various companies including STX, Hughes STX, Raytheon STX and finally Drexel University. He became a civil servant in 2007, joining the Laboratory for Space Weather, and supporting the Community Coordinated Modeling Center (CCMC) operations.

Peter develops and uses models of the solar corona and inner heliosphere which are designed for space weather research and forecasting communities. In 2010, most of his time was spent developing the CCMC infrastructure for Space Weather modeling, disseminating CCMC results to clients, and validating ongoing studies of all their models. In particular, he has characterized the performance of CCMC models when predicting observed solar wind speed and magnetic field strength near Earth. He also evaluated the precision of the current generation of models when predicting the field-line connectivity between the Earth and the Sun. Peter gave an invited talk on aspects of his model validation work at the fall meeting of the American Geophysical Union in San Francisco in December 2010.

Peter also leads the development of new tools for the space weather community. These efforts include potential, non-linear force-free, and full 3D magnetohydrodynamic models of the quasi-steady evolution of solar active regions. In addition his group is developing a range of tools needed to prepare observations of the photospheric magnetic field for use in these models, to determine the nature of flows in the photosphere which drive the evolution of these fields, and to analyze the model outputs.

Pertti Mäkelä

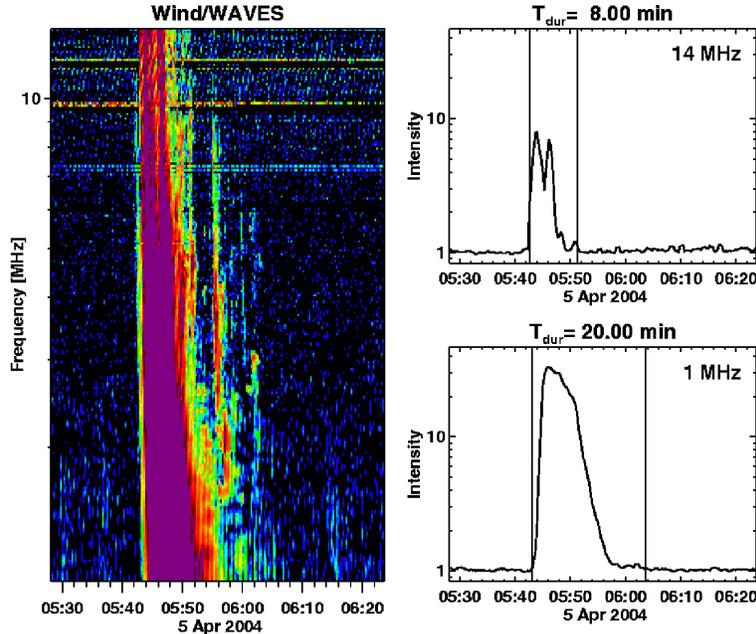


Dr Mäkelä is a postdoctoral researcher currently at the Solar Physics Laboratory (Code 671). He has been working at GSFC since January 2007.

He was born in Loimaa, Finland. He obtained his MSc in physics and PhD in space physics at the University of Turku, Finland. In Finland, he worked at the Space Research Laboratory in the Department of Physics, where he was involved mainly in the data analysis of the Energetic and Relativistic Nuclei and Electron instrument on SOHO.

Here at GSFC Dr Mäkelä helps with the Coordinated Data Analysis Workshop (CDAW) Data Center (<http://cdaw.gsfc.nasa.gov>) that maintains the extensively used SOHO/LASCO CME list as well as other CME-related data sets. He also helped organize two LWS CDAW meetings on GLE events and on CME flux ropes held in Huntsville in November 2009 and in San Diego in September 2010.

During FY2010, Dr Mäkelä continued his research with Dr Gopalswamy and the other members of the group, working on the analysis of SEP and CME observations by both spaceborne and ground-based instruments. The research has been focused primarily on solar radio bursts (type II and type III) together with SEP and ESP particle observations. Solar radio bursts, SEP, and ESP events all give information on particle acceleration processes in the solar corona and in interplanetary space. Studies suggest that complex, long-duration, low-frequency type III bursts are not crucial for SEP acceleration at the Sun as previously suggested.



Duration of a complex type III burst on 2004 April 5.

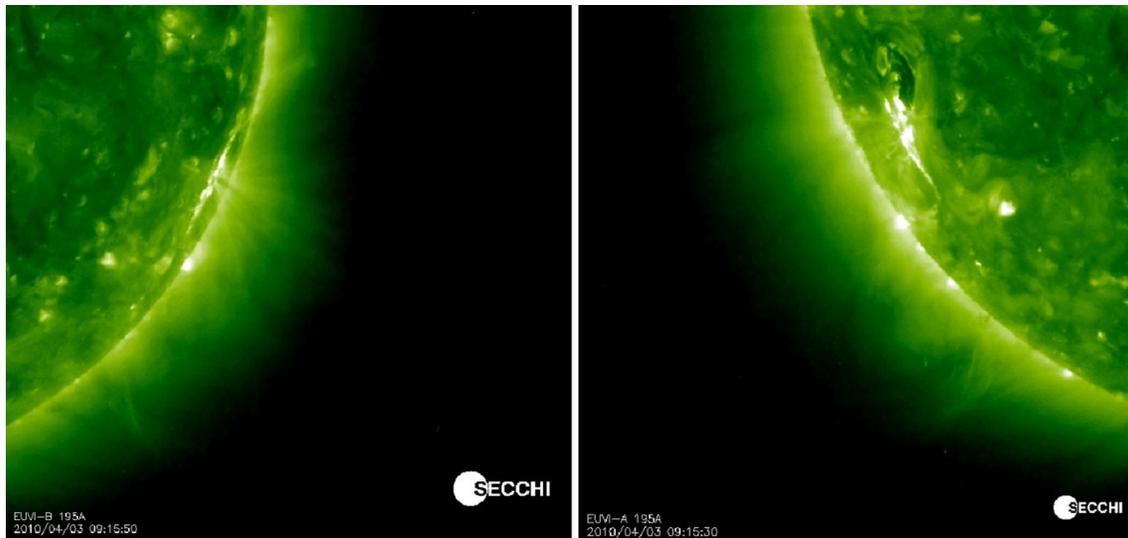
Mona Leila Mays



Dr Leila Mays began at GSFC in August 2009 as a NPP Fellow working with Dr Chris St. Cyr and Dr David Sibeck. She received a BS in physics and astronomy with high honors from the University of Maryland, College Park in 2004. A student of Dr Wendell Horton, Leila graduated with a PhD in physics from the University of Texas at Austin in August 2009.

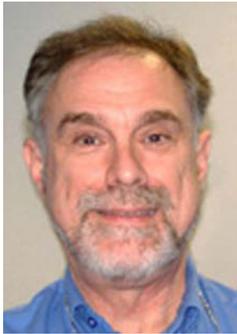
Leila has conducted a statistical study of stream interactions and CME events from January 2007 to December 2009 that result in storm and substorm activity. During this solar minimum, the decrease in solar activity has resulted in less geomagnetic activity. The observed activity, which ultimately arises from changes in the solar wind, came from stream interaction regions (SIRs), shocks, and some interplanetary coronal mass ejections (ICMEs). Geomagnetic activity was characterized by indices derived from ground-based magnetometers. Geoeffectiveness, defined as the strength and duration of geomagnetic activity, was compared with upstream solar wind conditions. During this two-year period, the most geoeffective storm events resulted from a combined CME and SIR interaction. ICMEs produced about 80% of the moderate storms, and SIRs produced 60% of the smaller storm events.

The magnetospheric responses to these events are being studied using the THEMIS dataset. Comparisons of CCMC magnetosphere models are made for each event, including a model for the solar wind driven Magnetosphere-Ionosphere system (WINDMI) that characterizes geomagnetic storm and substorm activity.



STEREO EUVI-B and A, 195 Å, showing the CME erupting on 2010 April 3 at 09:13 UT from active region 1059 following a GOES B7.4 class flare from S25W03 from 09:04-10:58 UT.

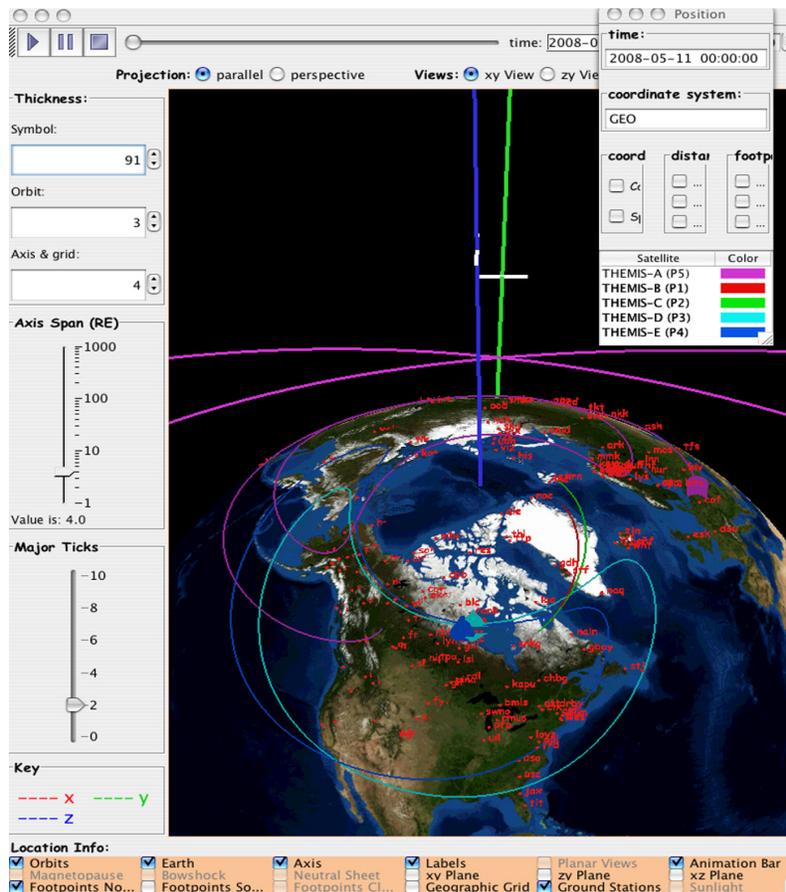
Robert E. McGuire



Bob (Dr Robert E.) McGuire is currently the Associate Director for Science Information Systems in HSD. In this role, he coordinates science data activities across the Division and represents the Division on various Directorate and Center groups.

Bob also leads and directs the Space Physics Data Facility (SPDF) project as its Project Scientist. SPDF is one of two designated heliophysics active final archives. SPDF ensures the long-term preservation and ongoing accessibility of important nonsolar heliophysics data from past, present, and future NASA missions. SPDF develops and operates multimission and active archive data and display services (e.g., CDAWeb and OMNIWeb); orbit planning and display services (e.g., SSCWeb and the 4D Orbit Viewer); and supports maintenance and use of the Common Data Format (CDF) standard, now used by many current NASA missions.

Bob has science interests in interplanetary particle composition and acceleration, as well as his work in science data systems and archives. He is a Co-I or Collaborator on several current heliophysics Virtual discipline Observatory (VxO) investigations, and was formerly a PI and Project Scientist on Interplanetary Monitoring Platform-8 (IMP-8).



Jan Merka

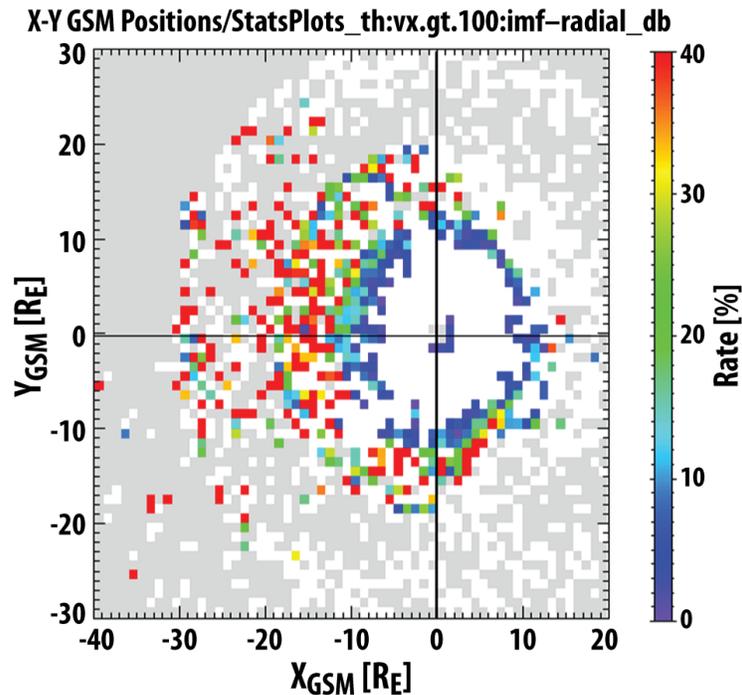


Dr Jan Merka received his PhD in plasma physics from the Charles University in Prague, Czech Republic. He began working as an Associate Research Scientist at the University of Maryland, Baltimore County in 2006. Located at GSFC since 2001, he works on several space physics research projects, and is the PI of the VMO.

Dr Merka provides essential support to the Heliophysics Science Division by developing Web and database systems for the emerging heliophysics virtual observatories. His primary area of research is the solar wind interaction with the Earth’s magnetosphere—in particular, the effect of solar wind plasma on the magnetosphere shape and plasma entry inside. Understanding solar wind plasma entry into the magnetosphere is important for developing better insight into magnetospheric processes and their effect on space exploration and ground systems.

As VMO PI, Dr Merka leads its development and collaborates with the VHO team to create unified, easy-to-use portals for heliophysics data discovery and retrieval.

In 2010, Dr Merka used VMO as a tool in his research of plasma transient flows observed by the THEMIS spacecraft to demonstrate its capabilities to the scientific community.

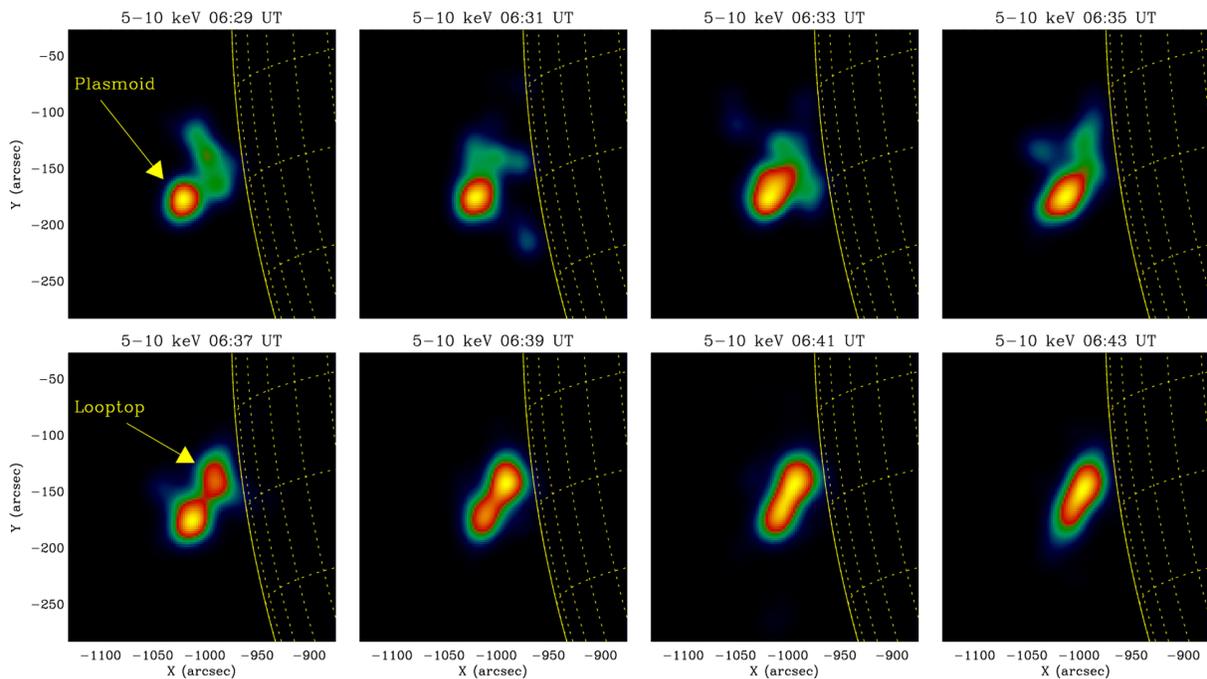


An occurrence rate of transient sunward plasma flows faster than 100 km/s observed by THEMIS spacecraft for times of nearly radial interplanetary magnetic field orientation.

Ryan Milligan



Dr Ryan Milligan is a former NPP Fellow continuing his work with Dr Brian Dennis as part of the RHESSI group, now at the Catholic University of America. His research primarily focuses on solar flare observations by combining data from RHESSI and other space-based instruments such as Hinode STEREO and SDO. In a recent publication, he presented evidence of the first plasmoid-looptop collision to be observed by RHESSI and STEREO during a CME eruption, and found that this collision resulted in a secondary episode of particle acceleration. These observations are important for understanding the energy release process during solar flares. These findings were presented at the recent 10th RHESSI workshop in Annapolis, MD, which he also helped organize. Dr Milligan is also one of the Max Millennium Chief Observers and often volunteers as a guest scientist for SDO's education and public outreach program. He is currently investigating the contribution of solar flares to the total solar irradiance using data from RHESSI and SDO.



Plot of two X-ray sources (a plasmoid and a loop-top source) merging in the corona during a CME eruption.

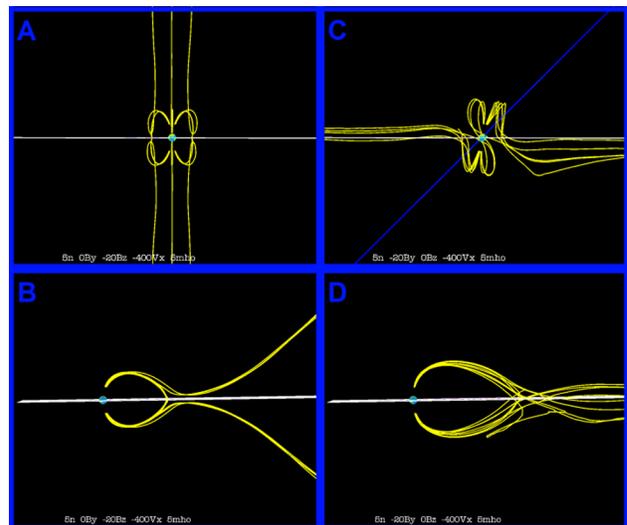
Elizabeth J. Mitchell



Dr Betsey Mitchell grew up in Alexandria, Virginia. She obtained her BS in physics from the University of Texas at El Paso in May 2005 and her MS in space science from Florida Institute of Technology in Melbourne, Florida in August 2007.

Betsey recently obtained her PhD in physics from the University of Texas at Arlington in May 2010. Working with Ramon E. Lopez, she studied the effects of the dawn-dusk oriented interplanetary magnetic field (IMF) on the transpolar potential, ionospheric Joule heating, and the ring current. Using both observations and simulations, she found that the ionosphere responds to the dawn-dusk oriented IMF, while the ring current does not. Examining the implications of these results, Betsey and Ramon discussed the possible decoupling between the magnetosphere and ionosphere for dawn-dusk oriented IMF. There was strong evidence that the decoupling was occurring through changes in the magnetic flux circulation. Betsey decided to propose to study the “magnetotail geometry effects on the energization of the ring current and radiation belts” for the NASA Postdoctoral Program (NPP).

Betsey is now an NPP fellow at GSFC working with Mei-Ching Fok. She is examining magnetic flux circulation and the implications of the Dungey cycle theory. The Dungey cycle theory describes magnetic flux circulation as a three-step process: dayside merging, nightside reconnection in the center of the tail, and magnetospheric convection. The figure shows 12 magnetic field lines in the magnetotail for southward IMF (A & B) and dawnward IMF (C & D). For southward IMF, the magnetic field follows the Dungey cycle theory, reconnecting in the center of the magnetotail. For dawnward IMF, the magnetic field is dragged both tailward and away from the Earth. This splits the magnetic lobes, making reconnection in the center of the nightside of the Earth impossible. Thus, dawnward IMF interactions with the Earth’s magnetic field do not result in magnetic flux circulation as described by the Dungey cycle theory.



Twelve magnetic field lines showing the general shape of the magnetotail for southward IMF (A and B) and dawnward IMF (C and D). Panels A and C are views from the Sun. Panels B and D are views from the duskside of the Earth.

Betsey is working to understand what type of magnetic flux circulation does occur for dawnward IMF and how that affects energy transfer between the solar wind and the magnetosphere and ionosphere.

Thomas E Moore



Originally from Portsmouth, NH, Dr Thomas Moore earned a BS and MA in Teaching from the University of New Hampshire (UNH) in 1971. He taught middle and high school for several years. He then went to the University of Colorado in Boulder to pursue a PhD in astrophysics, and returned to UNH as a postdoctoral position in 1979. He joined MSFC in 1983 to work on the NASA Dynamics Explorer and SpaceLab missions, as well as a number of sounding rocket payloads.

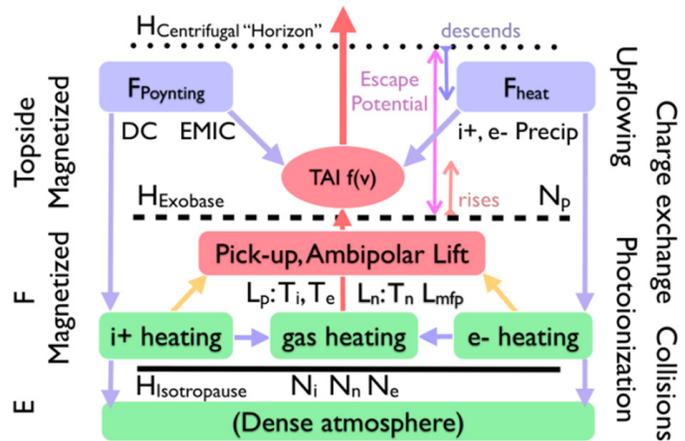
Dr Moore joined GSFC in May 1997. Since then, he has worked on the Polar mission as instrument PI, and briefly as Project Scientist, the IMAGE mission as Project Scientist and instrument Lead Investigator, and the Magnetospheric Constellation mission as Project Study Scientist; and studied the ablative effects of solar wind plasmas on Earth’s atmosphere. These roles involved collaborations with the UAH, UTD, SwRI, CETP, UofM, LMATC, ISAS, CESR, and many others, as well as numerous reviewing assignments and participation in groups such as the LWS TR&T Steering Committee, the last three NASA Heliophysics Roadmaps, the GEM Working Group on M-I Coupling, and the Solar Probe STDT.

Dr Moore has been the deputy director of the HSD since it was formed and recently was appointed Project Scientist for the Magnetospheric Multiscale (MMS) mission. He is also a co-investigator for the MMS Fast Plasma Investigation (FPI), co-investigator for the IBEX low-energy camera, and lead investigator for the KeV Ion Magnetic Spectrograph (KIMS) on the Rocket Experiment for Neutral Upwelling (RENU).

Dr Moore’s research interests focuses on the coupling between the atmospheres of the Sun, planets, small bodies, and the interstellar medium. These effects span the origin, evolution, and fate of our solar system.

In FY2010, Dr Moore’s research activities included modeling of entry pathways and circulation of solar wind and ionospheric plasmas into the magnetosphere, to form storm-time plasmas. In addition, he performed a study of mechanisms for ionospheric mass ejection, by plasma-gas wave-particle interactions in the auroral ionosphere, and modeled the heliopause ribbon observed by the IBEX mission as a reconnection feature. The resulting paper proved controversial, but was recently accepted and he hopes this will be a high impact paper.

Plasma Outflow Processes



A diagram of mechanisms involved in the ablation of ionospheric mass, when coupled with the solar wind, by an intrinsic magnetic field.

Karin Muglach

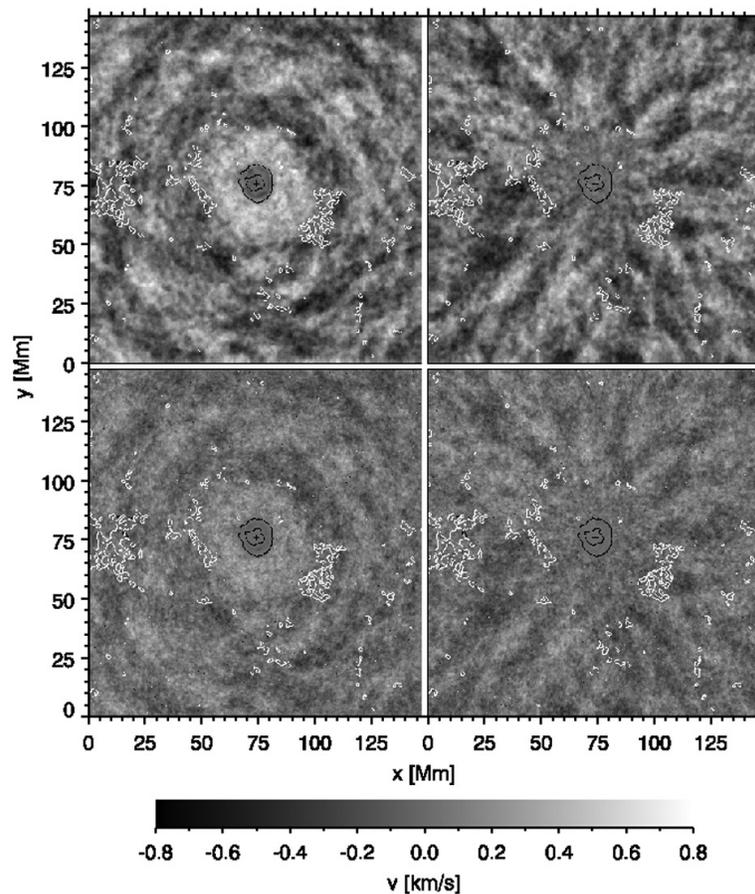


Dr Karin Muglach received her PhD from the Karl-Franzens-Universitaet Graz in Austria. She has worked as a postdoctoral fellow at ESA in the Netherlands and at solar research institutes in Germany before moving to the United States to work at the NRL. Her primary research theme is observational solar physics and includes:

- Solar spectro-polarimetry—especially in the infrared spectrum
- Structure and dynamics of solar active regions
- Formation, stability and eruption of filaments
- Source regions of the solar wind and coronal mass ejections
- Small-scale dynamics of the solar chromosphere and transition region

She has served on review panels for both NSF and NASA, and refereed papers for peer-reviewed journals. She is currently PI as well as Co-I of several successful proposals from NASA and NSF.

Dr Muglach joined GSFC at the beginning of 2010. She has started working on data from the HMI and AIA instruments of the recently launched Solar Dynamics Observatory with a focus on the photospheric magnetic field and its interaction with plasma flows.

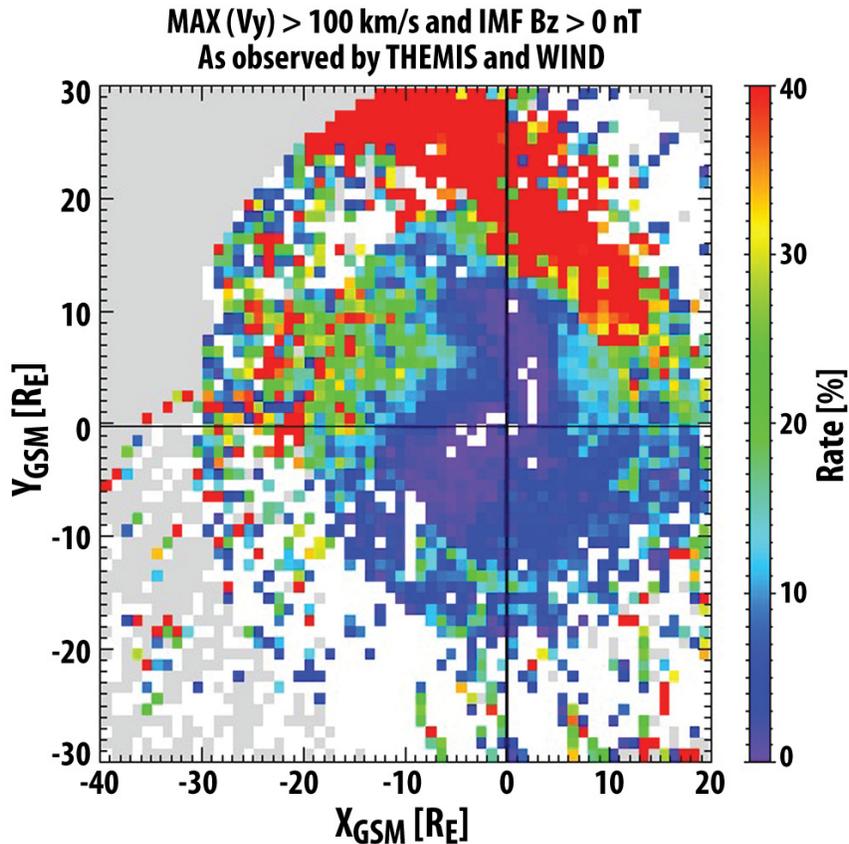


Tom Narock



Dr Tom Narock is a member of the Heliospheric Physics Laboratory and has been at GSFC since 2001. He earned a BS in astronomy from the University of Maryland, College Park and an MS in physics from JHU. Currently, Tom is pursuing a PhD at the University of Maryland, Baltimore County, in Information Systems. Tom’s work centers around the Heliophysics Data Environment where he has been PI or Co-I on several data access and data integration projects.

In FY2010, Tom was involved with several enhancements to the VMO and VHO projects, whereby the two systems now provided uniform search and retrieval capability over several hundred heliophysics data sets. The VMO, in particular, now provides a single point of access to over 600 magnetospheric data sets. Both systems provide advanced search and visualization routines that enable faster, and more efficient, identification of time periods and data sets of interest.



The occurrence rate of $B_z > 0$ nT is shown for the five THEMIS spacecraft when WIND simultaneously measured a time interval with a maximum V_y value larger than 100 km/s. All time intervals were returned by the VHO and VMO within minutes, alleviating the need for manual search.

Teresa Nieves-Chinchilla

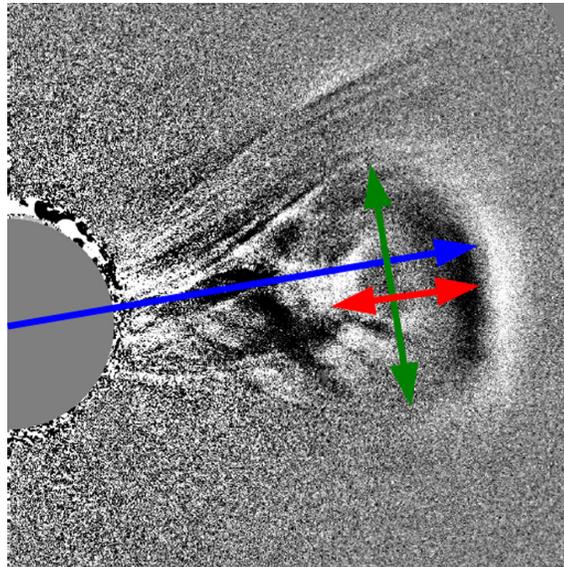


Dr Teresa Nieves-Chinchilla was born in Madrid, Spain. She obtained her degree in theoretical physics from Autonomia University of Madrid, and her PhD from Alcala University in Alcala de Henares, Spain (a small, historic town close to Madrid) in 2004.

She joined the NASA Postdoctoral Program in May of 2006. During the first part of her postdoctoral fellowship, she used WIND/SWE data to investigate the properties of electrons in magnetic clouds. After that, she worked with high-time-resolution data from the Cluster/PEACE to study the kinetic aspect of the electron distribution function. She focused on the strahl electron component to understand its properties, sources, and the role in processes that regulate instabilities.

In 2010 Teresa joined the Heliophysics Laboratory (Code 672) with the goal of studying and analyzing the mechanisms and process carried out in coronal mass ejection (CME) propagation and evolution in the interplanetary medium. To accomplish this goal, she combines the analysis of data from in situ instruments onboard WIND, ACE, or STEREO with the remote observations from STEREO and SOHO. In addition to data analysis, she is linking the analytical in situ models for the magnetic clouds with the “empirical flux rope model” to develop a global magnetic cloud model that allows connection of the CME on the Sun with interplanetary CME on the Earth.

Teresa collaborates with the Solar Physics group at the Naval Research Laboratory. She was also invited to give a course about space scientific data as visiting professor with her alma mater, Alcala University.



The three parameters we used to describe the CME in the remote-sensing data: front elongation (blue), red parallel diameter (red) perpendicular diameter (green).

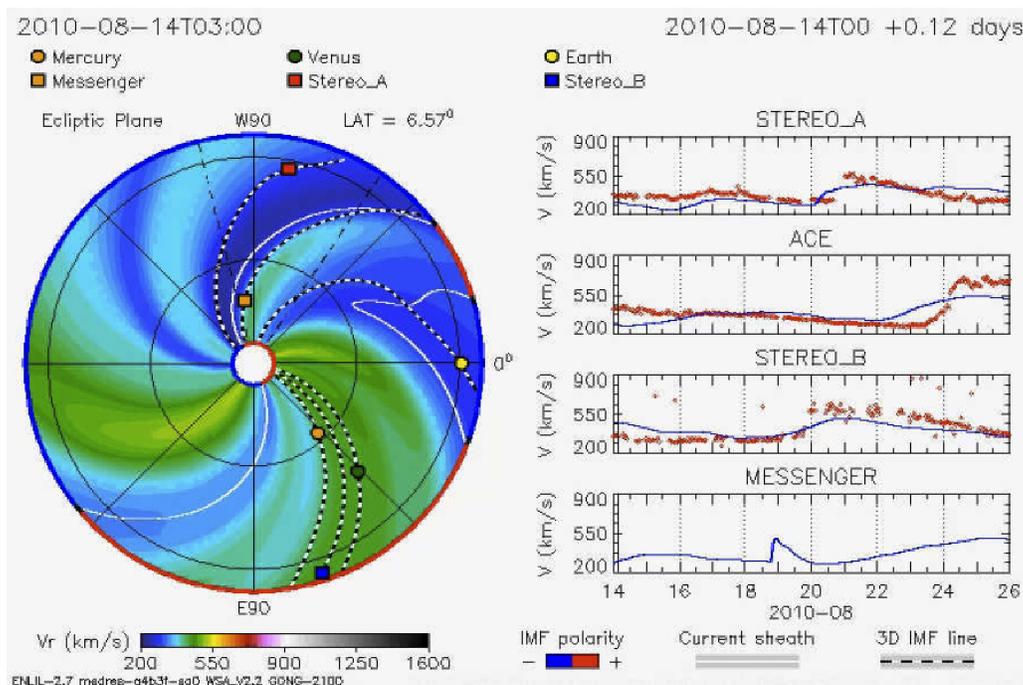
Dusan Odstrcil



Dr Dusan Odstrcil is a senior research scientist in the Space Weather Laboratory at GSFC and a research professor at George Mason University. He obtained his PhD in plasma physics from the Comenius University, Bratislava, Czechoslovakia in 1984. He worked at the University of Colorado in Boulder and the NOAA/NWS Space Weather Prediction Center for 12 years specializing in numerical modeling of solar wind and transient disturbances. He moved to the Washington, DC, area in January 2010.

Dusan is interested in modeling and forecasting heliospheric space weather. He has developed the numerical 3D magnetohydrodynamic code, ENLIL, for simulating global dynamic phenomena in the solar wind, including corotating interaction regions, coronal mass ejections, and interplanetary shocks. ENLIL was selected by the NASA Community Coordinated Modeling Center to provide experimental forecasting and run-on-request services to the space weather community (<http://ccmc.gsfc.nasa.gov>) and the NOAA/NWS Space Weather Prediction Center for transitioning into operations.

Dusan studies the evolution of heliospheric disturbances and continues his software development to provide better mission support. He has authored or coauthored six papers.



The animation shows predicted solar wind in the ecliptic plane (left) and as temporal profiles at NASA spacecraft (right) in August 2010. The radial velocity component is shown using the color scale. The heliospheric current sheet (white) and the magnetic sectors polarity are indicated at computational region negative (blue) and positive (red) boundaries. The black-and-white lines show the interplanetary magnetic line passing through planets and spacecraft. Left panels show the temporal profiles at STEREO-A, ACE, STEREO-B, and Messenger spacecraft. Blue curves show numerical prediction and red dots show spacecraft beacon data.

Leon Ofman

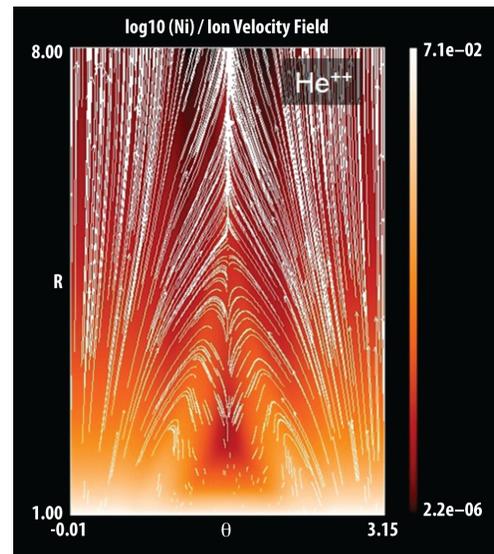


Professor Leon Ofman is working on theoretical research in solar and space physics. His studies are driven by data obtained by NASA and other solar satellites. He has been working at GSFC since 1992. He obtained his PhD at the University of Texas at Austin, and his BSc and MSc at Tel Aviv University in Israel. He supervises several postdoctoral researchers who work on STEREO/COR1 and Hinode/EIS data analysis and modeling at GSFC. He is a research professor in the Department of Physics, The Catholic University of America, and visiting associate professor at Tel Aviv University. He has served on NASA review panels, and as a reviewer for leading journals.

Professor Ofman's main research goals are to understand the transport of energy in the solar corona, to comprehend heating and acceleration of the solar wind, and to interpret observations in terms of the underlying physical processes. These goals are important for the study of the Sun-Earth connection, space weather, and other applications requiring the characterization of the heliospheric physical conditions. His main methods are based on numerical models of the coronal and interplanetary plasma. He uses 3D magnetohydrodynamic modeling to study the oscillation of solar coronal loops in solar coronal active regions. These studies have led to a better understanding of wave energy trapping and dissipation in active regions, and the development of the new field of coronal seismology.

Professor Ofman also studied interplanetary shocks and heating of multi-ion solar wind plasma using 1D and 2D hybrid models, and used multi-fluid models to study the acceleration of the solar wind in coronal streamers. He collaborated with several senior members and postdoctoral scholars at HSD on these studies. He has also collaborated with several researchers in the international research community. The studies improved our understanding of solar wind heating and acceleration as seen with various space-based EUV telescopes and imaging spectrometers, such as SOHO/UVCS and Hinode/EIS.

In FY2010 Professor Ofman authored and co-authored 7 papers that were published in refereed journals, 4 proceedings papers, and 13 meeting presentations. Six other papers were in various stages of publication. He was awarded four new NASA grants, and continued working on several NASA grants.



Results of three-fluid numerical model of a coronal streamer showing the flow pattern and density of He⁺⁺ ions in region 1 to 8 solar radii

Keith Ogilvie



Dr Ogilvie has been at GSFC since 1967; he was originally an NRC fellow. He received both BSc and PhD in nuclear physics at the University of Edinburgh. He is working on observations of phenomena in the interplanetary medium, especially plasma and solar related; the reduction and interpretation of plasma data; and development of plasma instrumentation.

During FY2010, it has become rather likely that DSCOVER—formerly Triana—will be refurbished and launched in CY2013 on an Air Force spacecraft to be used as a space weather and earth observation system at L1. Refurbishment and recalibration will be required, and preparation for this has been a principal activity during the year. No “official” money has yet been made available but some things have been accomplished, including:

- Planning for the replacement of the channel plates in the electron spectrometer prior to recalibration. This requires the design and construction of a new high voltage power supply.
- Arranging with Justin Kaspar of the Smithsonian Solar Laboratory to come to GSFC and supervise the recalibration of the Faraday cup have been made, all cables etc, needed for this work are available

During the next period the data system will be studied to find and make any changes that may be required.

Work has commenced on assessing the use of coated channel plates to increase the dynamic range which can be covered. The results might be used on DSCOVER.

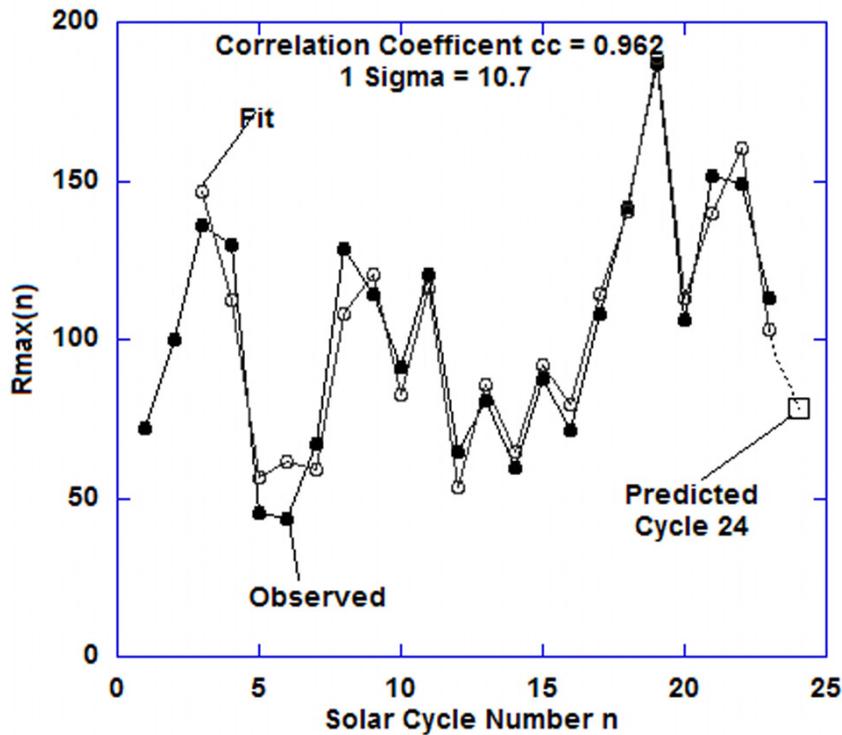
The paper on the causes of very low density periods observed in the Solar Wind is still being reviewed and may be submitted soon.

Vladimir Osherovich



Dr Vladimir Osherovich (CUA) received his MSc in theoretical physics from St Petersburg University and his PhD from the Main Astronomical Observatory (Pulkovo) of the Russian Academy of Science.

In collaboration with Dr Fainberg (Code 673), Dr Osherovich has been developing a new method to predict the amplitude of the next solar cycle. All previous methods to predict the amplitude of cycle n (R_{nmax}) based only on sunspot numbers (SSN) from previous cycles have an accuracy of about 70%. To boost the accuracy, 40 years ago the Russian scientist Ohl suggested the use of geomagnetic index “aa” for predicting R_{nmax} . Unfortunately, the record available for “aa” is only 150 years—which does not cover all solar cycles. Drs Osherovich and Fainberg have put forward a new method to forecast R_{nmax} based only on values of R_{max} and mean values of SSN for the previous cycles. Their accuracy is 96%. Their prediction with Hathaway’s 2-year Gaussian filter for cycle 24 is $R_{24max} = 78 \pm 10$.



Natalia Papitashvili



Dr Natalia Papitashvili received a PhD in Solid-Earth Geophysics and Geomagnetism from Moscow State University. She arrived at GSFC in 1992 and provided support to the National Space Science Data Center for several years.

She is a support scientist in the Space Physics Data Facility. She has helped to define, and has implemented, the evolution of widely used SPDF data systems such as OMNIWeb, COHOWeb, HelioWeb, FTPBrowser, and, most recently, OMNIWeb-Plus, which is an integrating interface to all SPDF-resident data relevant to heliospheric research.

She has been the key person in maintaining and extending the multisource compilation of solar wind and related data called OMNI. Her expertise in “data cleaning” was important in her recent final processing of 1973–2000 IMP 8 magnetic field data at 0.32-s resolution.

She is recognized internationally for the creation and evolution of Corrected Geomagnetic Coordinates. Most recently she has also supported the Virtual Energetic Particle (VEPO) and the Virtual Ionosphere-Thermosphere-Mesosphere Observatories (VITMO).

Vasant Patel



Vasant Patel is the Principal Systems Administrator in HSD. A native of Gujarat State in India, he received his BE in electrical engineering (specializing in microprocessors and their architecture) from North Gujarat University in 1994 and his MS in electrical and computer engineering (specializing in networking, communication, cryptography and network security) from George Mason University, VA, in 2002. In India, he worked as an electrical engineer for one of the top companies (producing starch, glucose, dextrose, and sorbitol), where he was managing power plants, electrical sub-stations, turbines, generators, and large-size electrical motors. Later he worked as Assistant Professor at a large engineering college in Gujarat state teaching bachelors- and masters-level students. Since 1998 he has been working for various companies in the United States, progressing from Network Administrator through to Senior Systems Administrator/Network Engineer.

Vasant joined GSFC five years ago with an extensive knowledge of computer systems, network systems, security, and applications. Since then he has worked with Astrophysics Science Division and Solar Physics Science Division managing a wide variety of computer systems including Windows, Mac, Linux, and UNIX operating systems. Vasant has obtained various industry-standard certifications from Microsoft, Cisco, Check Point and CompTIA, which make him unique in his field.

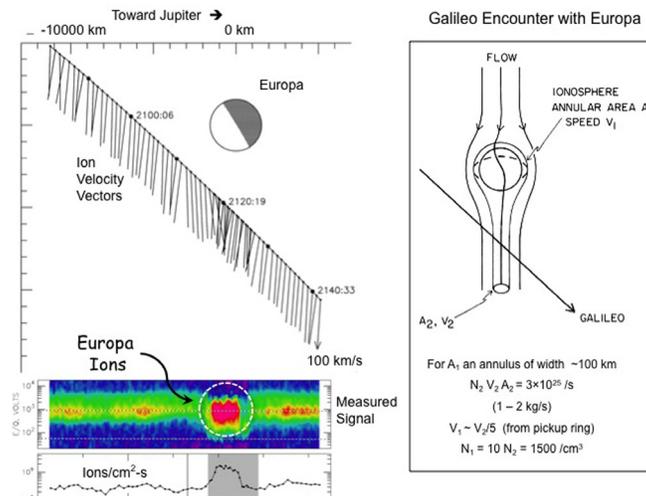
In FY2010, Vasant has received two back-to-back Peer Awards for Outstanding Customer Support and Exceptional Service Skills—one from his company, Adnet Systems; the other from the HSD.

William Paterson



Dr William Paterson is a Research Astrophysicist in the Heliospheric Physics Laboratory (Code 673). He joined NASA in July 2010 to participate as Deputy Principal Investigator for the Fast Plasma Instrumentation (FPI) being developed for the Magnetospheric Multiscale Mission (MMS). MMS is a mission dedicated to studying of the process of magnetic reconnection that play a fundamental role in maintaining plasma and radiation environments within the solar system and throughout the universe. Dr Paterson obtained his PhD in physics from the University of Iowa based on measurements of the Earth’s magnetosphere from NASA’s ISEE-1 spacecraft. He later gained extensive experience in analyzing measurements of the space environments of Earth and other planets as a Research Scientist at the University of Iowa and as an Associate Professor at Hampton University in Virginia. At Hampton he also helped develop a graduate program in atmospheric and planetary sciences, which he administered as Program Coordinator and Departmental Chairperson.

Dr Paterson’s research in plasma physics seeks to understand processes affecting the space environments of Earth and other bodies, especially Jupiter and its moons. He is a former Co-Investigator and current Principal Investigator for U.S. plasma instrumentation for Geotail, a joint mission between the United States and Japan, and he served as Co-Investigator for plasma science for the Galileo mission to the Jupiter system. His personal achievements include developing innovative techniques for analysis of observations from the Galileo mission—an effort that led to important discoveries and helped achieve success despite the near-crippling loss of the spacecraft’s high-gain antenna. He was a key member of a collaborative effort with scientists at UCLA that demonstrated the capabilities of computer simulations for accurate description of space weather events, and he participated in pioneering work comparing spacecraft images of the Northern Lights with observations of the particles and the electric and magnetic fields in space which cause those mysterious emissions.



Observations (left) and simple model (right) illustrating the loss of ionospheric plasma from the moon Europa due to entrainment by Jupiter’s magnetic field.

W. Dean Pesnell

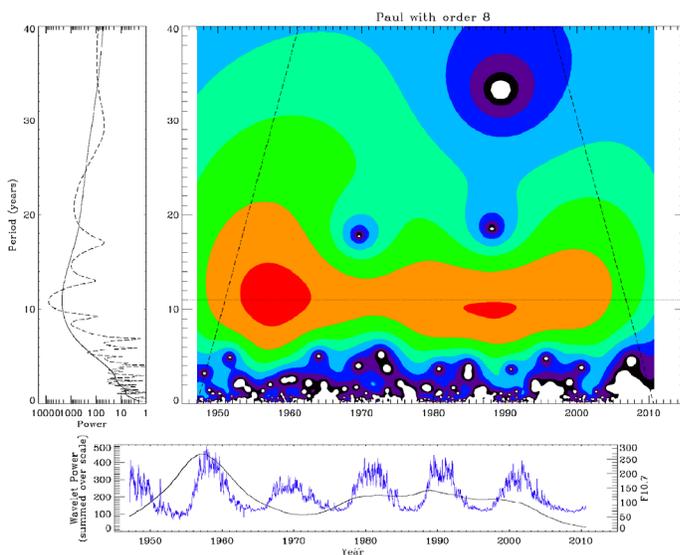


Dr Dean Pesnell was born in Wilmington, DE. He received his BS in physics from the University of Delaware and his PhD from the University of Florida. After a postdoctoral fellowship at the University of Colorado and a visiting professorship at New Mexico State University, he came to GSFC as a contractor in 1990. He formed Nomad Research, Inc. in 1995 to perform research with GSFC. One series of contracts was to design the LWS Geospace missions. He started work on the Solar Dynamics Observatory (SDO) in 2004 and became the Project Scientist in 2005. He has published 80 papers in a variety of research areas including variable stars, the Sun-Earth connection, quantum mechanics, and meteors in planetary atmospheres. Dean celebrated the launch of SDO during FY2010. The observatory became an operational mission on 2010 May 1 and has

since returned excellent science data. Three SDO press conferences were held, one before launch and the next two after data started to flow.

FY 2010 was also a busy year for research and outreach. A paper on the wavelet analysis of solar activity was prepared for submission to Solar Physics. The prediction of solar cycle 24 and the discussion of the current solar minimum continued to occupy a prominent spot in his research. Solar Physics accepted a paper analyzing a well-known prediction method, and talks describing solar minimum were given at several venues. Both efforts are related to the long-term manifestations of the solar dynamo in observations.

Peter Williams was renewed as a postdoctoral fellow studying observable changes in the convective velocity spectrum. Shea Hess Webber (GMU) and Nishu Karna (GMU) returned as graduate students to continue the analysis of the area of the polar coronal holes. Another summer intern, Adam Jacobs (Millersville), analyzed waves seen during the launch of SDO. Adam's work will be presented in January at the Annual Meeting of the American Meteorological Society. Collaborative work on the interpretation of SABER data (especially the water vapor measurements) continued with Dr Feofilov, Dr Kutepov, and Dr Goldberg (all 674).



A Paul wavelet spectrum of the F10.7 solar radio irradiance. There are three panels on this plot: the upper right is a contour plot of the wavelet power normalized by the variance of the data; the lower-right plot is the sum of the power-over scale showing how the wavelet power is a smoothed version of the data; and the upper-left plot shows the sum over time and a Lomb-Scargle periodogram of the data (dashed line) showing how the power is a smoothed version of the Fourier transform. The black dashed lines in the contour plot show the zone of influence, and the dotted horizontal line is drawn at a period of 11 years for reference.

Robert F. Pfaff



Dr Robert F. Pfaff Jr. joined GSFC in 1985, soon after receiving his PhD from Cornell University. He is currently a Space Scientist with the Space Weather Laboratory in HSD. Dr Pfaff has served as Project Scientist for the FAST satellite since 1990, Project Scientist for the Sounding Rocket program since 1994, and NASA Project Scientist for the Air Force C/NOFS satellite since 2003.

As Study Scientist, Dr Pfaff led the Ionospheric Mappers planning for the LWS program, and later served on the Geospace Mission Definition Team for LWS. He has served on the Geospace Electrodynamics Connections (GEC) definition team, as well as on the Magnetospheric Management Operations Working Group (MOWG) at NASA Headquarters.

Dr Pfaff's experimental electric field research has involved advancing electric field double-probe research techniques, including the fabrication of low-noise detectors, burst memories, and onboard signal processing such as the C/NOFS satellite and numerous sounding rockets, new low-cost boom systems, and miniature spherical payloads with dual-sphere, vector double probes, Langmuir probes, and magnetometers.

Dr Pfaff is the PI of the Vector Electric Field Investigation (VEFI) on the C/NOFS Air Force satellite, launched in 2008, that includes a vector DC and AC electric field detector, magnetometer, Langmuir probe, lightning detector (developed with the University of Washington) and burst memory. Within NASA's sounding rocket program, Dr Pfaff has provided electric field, magnetic field, and plasma density measurements for 42 rocket missions to date. All of the hardware has been delivered on time and on budget and all experiments have worked exceptionally well.

Thomas B. Plummer



Tom is co-located with the Solar Physics Laboratory (Code 671) from the Power Systems Branch (Code 563). In addition to power systems, he brings expertise in optical alignment, ultra-high-vacuum systems, high-voltage design, and flight materials for encapsulation and conformal coating. He has been responsible the fabrication and design of critical ground support equipment for many instruments of the Solar Physics Laboratory, and is currently working on the SPICE instrument on Solar Orbiter and the EUNIS sounding rocket payload.

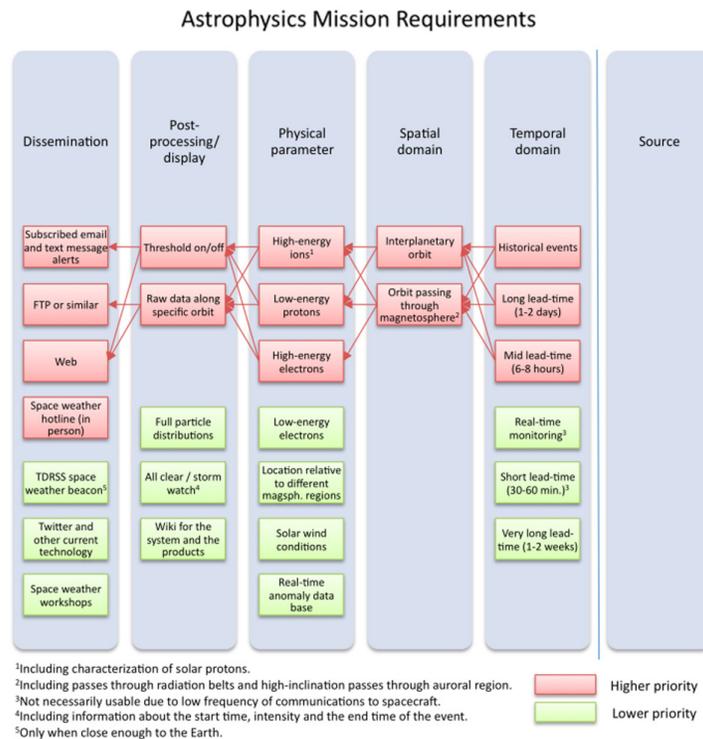
Antti Pulkkinen



Dr Pulkkinen is currently Research Associate at the Catholic University of America. He received his PhD in theoretical physics from the University of Helsinki, Finland in 2003. Subsequently he joined the nonlinear dynamics group at GSFC to carry out his postdoctoral research in 2004–2006. Since 2006, Dr Pulkkinen has been on staff at the Community Coordinated Modeling Center (CCMC) operated at GSFC. His current work uses the established modeling capabilities in quasi-operational space weather monitoring and forecasting.

Dr Pulkkinen led the team that organized the Space Weather and NASA Robotic Missions Operations Workshop in September 2009 and September 2010 at GSFC. He was the lead author of the requirements document that resulted from the 2009 workshop (see figure). Dr Pulkkinen has been co-designing and co-operating GSFC Space Weather Desk functions that include space weather alerts and weekly reports for the NASA robotic mission operators.

Dr Pulkkinen’s scientific activities in FY2010 focused on improved modeling and forecasting of space weather. He worked on quasi-operational tools that enable both automatic and manual determination of 3D CME parameters from different sets of coronagraph data. Dr Pulkkinen also worked on extensive community-wide metrics-based validation and comparison of magnetospheric models capable of predicting ground magnetic field perturbations. The validation work will be supported by the NSF award Dr Pulkkinen received for deriving ionospheric electric currents by combining space- and ground-based magnetic field observations from NSF’s AMPERE and SuperMAG projects.



An example of the requirements charts prepared based on the NASA robotic mission operator input.

Douglas Rabin

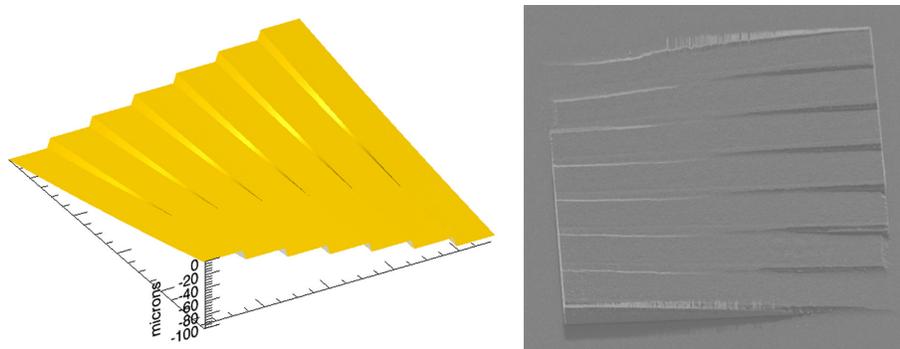


Doug Rabin has been at GSFC for ten years as chief of the Solar Physics Laboratory. He received his AB from Harvard College and PhD from the California Institute of Technology. After postdoctoral work at the University of Cambridge and MSFC, he was a staff member of the National Solar Observatory. His research is focused on the structure and dynamics of the solar corona.

Rabin is Deputy Project Scientist of the on-orbit Solar Radiation and Climate Experiment (SORCE) and Instrument Scientist of the Reflected Solar Spectroradiometer on the Climate Absolute Radiance and Refractivity Observatory (CLARREO), a mission under development. He serves on the Users Committee of the National Solar Observatory.

Rabin is the Principal Investigator of the Extreme Ultraviolet Normal Incidence Spectrograph (EUNIS) sounding rocket experiment, which is scheduled to fly for the third time in 2011, following two successful flights in 2006 and 2007. The unprecedented sensitivity of EUNIS allows it to probe intensity and velocity variations in solar plasmas on timescales as short as 10 s. Transient and small-scale events are increasingly recognized as an important source of outer atmospheric heating. The EUNIS Team received a 2009 NASA Group Achievement Award.

Rabin is involved with instrument and technology development in several areas, including heliospheric imaging and integral field spectroscopy. The figure shows a concept for a reflective image slicer that could be used in a UV/EUV integral field spectrograph, together with an early-stage test article implemented with gray-scale microlithography in the GSFC Detector Development Laboratory. This work was supported by the GSFC Internal Research and Development program.



Left: geometry of a reflective image slicer. Each slice is 0.9 mm long and 0.13 mm wide. Right: scanning electron micrograph of a test article implemented with gray-scale microlithography. Further work is needed to decrease the figure error and roughness of the slices.

Lutz Rastätter

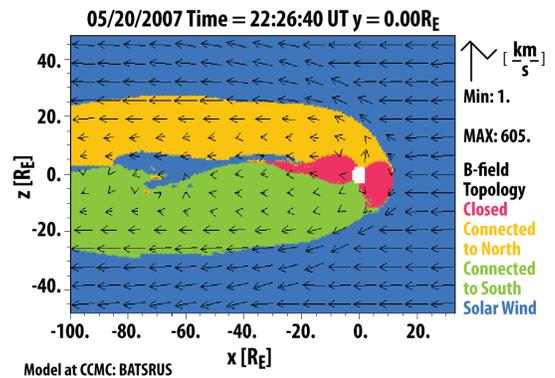


Lutz was born in Germany and obtained his PhD in theoretical astrophysics at the Ruhr University of Bochum, Germany, in 1997. He then joined Michael Hesse at GSFC as a postdoctoral research associate to work on plasma sheet thinning and reconnection in the magnetotail. In FY2010, he was hired by NASA's Space Weather Laboratory as a research astrophysicist. Since the start of the Community Coordinated Modeling Center (CCMC) in 2000, he has been applying his experience in magnetohydrodynamic modeling and magnetospheric physics to implement, test, and run various space physics models as well as develop the visualizations that form the backbone of online services at CCMC. His primary research areas are the validation of numerical research models of the corona, heliosphere, magnetosphere, and ionosphere/ thermosphere.

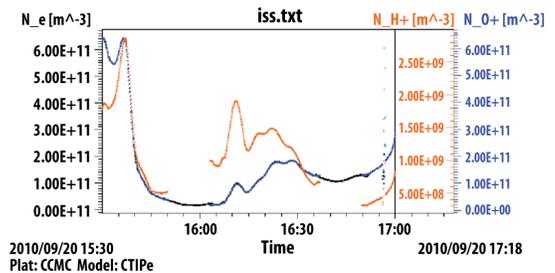
In FY2010, Lutz created a faster algorithm to compute the topology of the magnetospheric magnetic field. Magnetic field lines are traced from vertices on an adaptive mesh instead of a fixed-resolution mesh, speeding up the process by a factor of up to 30. This method can be applied online and in automated, real-time visualization.

Dr Lutz recently refined the time-series data methods that are being employed to validate an ionosphere model against plasma measurements on the International Space Station (ISS). The study will soon include ionosonde data. In the future, model results will complement real-time plasma instrument data in space station operation.

Recent model validation work includes the 2008 and 2009 GEM modeling challenges where model results and observations are compared. Differences in performance between models and of different settings of any given model can be analyzed. The study is being extended to Dst index and cross-polar cap potential values.



Magnetic field topology in global magnetosphere simulation: blue = solar wind, yellow = connected to northern hemisphere, green = connected to south, red = closed field lines.



CTIPe model output of N(e), N(H⁺), N(O⁺) that is being compared to measurements at ISS.

Nelson Leslie Reginald

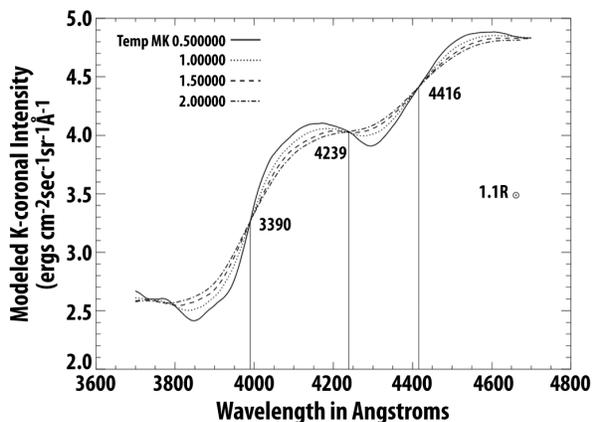


Nelson was born in Kandy, Sri Lanka. He first qualified as a Management Accountant from the Chartered Institute of Management Accountants (CIMA), United Kingdom, in 1990; he then obtained his BSc (Hons.) in physics and pure mathematics from the University of Peradeniya, Sri Lanka in 1994, and MS and PhD in physics from the University of Delaware in 1997 and 2000, respectively. He conducted his dissertation work at GSFC with Dr Joseph Davila under a NASA Research Fellowship awarded to him through the University of Delaware. The dissertation work revolved around modeling the K-coronal spectrum, designing the Multi Aperture Coronal Spectrograph (MACS) to capture the K-coronal spectrum during a solar eclipse, and successfully operating MACS in conjunction with the total solar eclipse of 1999 August 11 in Elazig, Turkey, to measure the electron temperature and its flow speed in the low solar corona.

Since graduation, Dr Reginald has continued his work at GSFC through the Catholic University of America. During the last ten years, Dr Reginald traveled with the eclipse team headed by Dr Davila to four more eclipses, namely the total solar eclipses of 2001 June 21 in Zambia, 2002 December 4 in South Africa, 2006 March 29 in Libya and 1 August 2008 in China. The results from these eclipses yielded a technique that allows for simultaneous and global measurements of both the electron temperatures and its flow speeds at multiple points in the low solar corona together with a technique to create maps of these two physical parameters (see Reginald et. al. (2009)).

In FY2010, Dr Reginald was also involved in characterizing the Polarization Camera, which has the ability to measure both the intensity and the state of polarization of the incident light on a pixel-by-pixel basis. In addition, he is working with Dr William Thompson in designing the test facility to enable characterization of the camera designed for the Spectral Imaging of the Coronal Environment (SPICE) instrument that will launch on board the Solar Orbiter Spacecraft.

Dr Reginald was also involved with the Students Enthusiastic about Science and Math (SUNBEAMS) program aimed at encouraging students attending public schools in Washington, D.C. towards science and math. As a part of this program, he conducted demonstrations with liquid nitrogen and taught some physical concepts associated with those demonstrations.

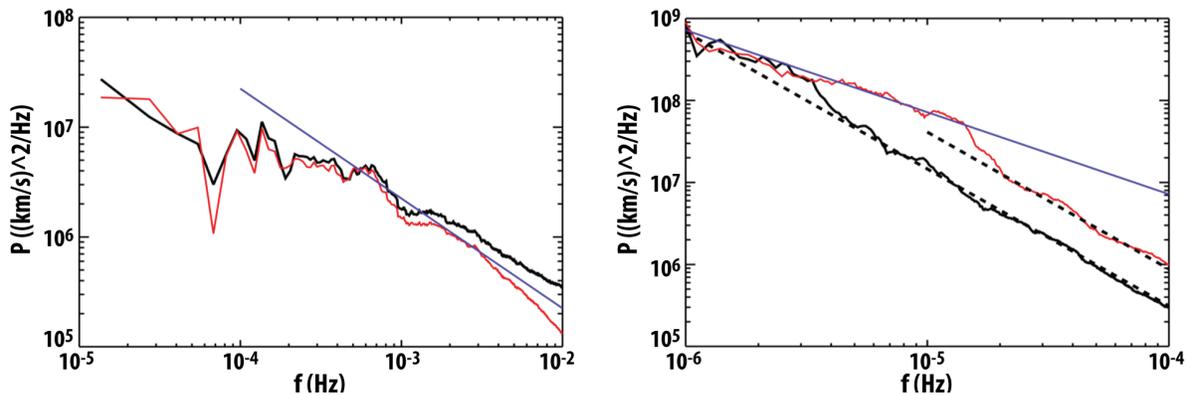


Modeled K-coronal spectra for assumed coronal electron temperatures of 0.5, 1.0, 1.5, and 2.0 MK. The measured spectra are compared with models to determine the electron temperature.

D. Aaron Roberts



Dr Roberts has been a physicist with the Heliospheric Physics Laboratory since 1989. He is actively involved in research on interplanetary turbulence and the modeling of nonlinear processes. His observational and MHD simulation efforts in these areas have shown that such processes are necessary to explain the observations and trace the evolution of the interplanetary turbulence from 0.3 to 20 AU. He is the author of over 100 publications in this and other areas. He received both SB and PhD degrees from MIT, the latter in 1983. His recent work has concerned the evolution of the spectrum of fluctuating fields in the solar wind, and constraints on solar wind acceleration models that make wave acceleration scenarios unlikely. He has presented this work and many other papers at AGU, SHINE, Solar Wind, and other meetings.



The spectra of velocity (black) and magnetic (red) fluctuations of the solar wind flows undergoes a systematic evolution from near the Sun (left; $\frac{2}{3}$ of the way from the Earth to the Sun) to farther out (right; 5 times the Earth's distance from the Sun). Roberts [2010, JGR] showed that the spectra of these two quantities, which had often been assumed to be tightly coupled in a turbulent cascade, evolve in different ways—eventually reaching the same slope (right), but with the velocity spectrum being “turbulent” (dotted line) over a wider range of scales and lower in amplitude. The blue line has the same slope in both graphs.

As the Project Scientist for the Heliophysics Data and Model Consortium (HDMC), Dr Roberts works with other NASA HP Data Centers to make data easily accessible and usable via Virtual Observatories and other means. He continues his work with NASA HQ on issues such as the Heliophysics Science Data Management Policy. The HDMC work involves other agencies, such as NSF, as well as foreign partners, including collaboration with the European “HELIO” project, to provide worldwide integration of HP data systems. In addition, he has served on NASA proposal review panels and as referee for various journals (JGR, ApJ, etc.).

Nancy Grace Roman



Stellar is a word that aptly describes the career of Dr Nancy Grace Roman. Throughout her career, Dr Roman has been an active public speaker, educator, and a pioneer and advocate for women in the sciences. Her initiatives set the foundation for NASA's preeminence in space astronomy.

Hailing from Nashville, TN, Dr Roman obtained her BA in astronomy from Swarthmore College in 1946 and her PhD in astronomy from the University of Chicago in 1949. She continued her career in stellar astronomy with Chicago, advancing from postdoctoral fellow to instructor to assistant professor between 1949 and 1955. She then moved to the U.S. NRL's Radio Astronomy Branch, where she became the head of the Microwave Spectroscopy Section.

NASA recruited Dr Roman in 1959, the year after its inception, to establish a program in space astronomy at optical and ultraviolet wavelengths. At NASA, she continued to distinguish herself as both a scientist and a leader, assuming positions of increasing responsibility within the astronomy program. In 1979, she retired as Chief of Astronomy and Relativity Programs, overseeing all of NASA's efforts in Space Astronomy. Dr Roman's programs laid the groundwork for the research conducted by the Orbiting Solar Observatories, the Viking probe of Mars, the Copernicus satellite, the U.S. space station Skylab, and the Hubble Space Telescope.

Dr Roman is still actively engaged with the future through her outreach activities as an Emeritus Scientist. Recently, she has reviewed proposals for Exploravision Awards, which accepts proposals from K-12 teams describing useful inventions not possible now but possible in 20 years. She has judged science fairs and participated in teleconferences at Air and Space Museum with schools in Idaho, Britain, DC, Virginia, and North Carolina. She is also involved with the NASA Alumni League Executive Committee.

Douglas Rowland

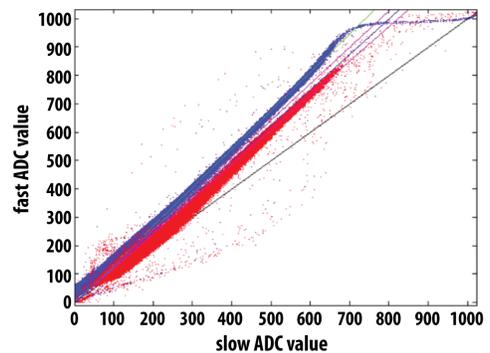


Douglas Rowland has worked as a space physicist in GSFC's Heliophysics Division since November 2003, first as a National Research Council postdoctoral fellow and since 2005 as a civil servant. Dr Rowland works in the electric fields group developing instrumentation to measure the electric fields responsible for charged-particle transport and energization, as well as leading projects dedicated to studying energetic particle acceleration in regimes ranging from auroral-zone ion outflow to thunderstorm-driven electron acceleration.

Dr Rowland's research continues to focus on topics relating to magnetosphere-ionosphere coupling and energetic-particle acceleration processes. This past year he has focused on delivering and integrating the PISA instrument to the MSFC's FASTSAT payload, which is expected to launch in late November 2010; as well as finishing the development of the NSF-funded Firefly CubeSat mission, with launch in summer 2011. Firefly has undergone initial testing in the GSFC electron beam facility and is expected to enter environmental testing in February 2011. Firefly promises to provide the first direct evidence for MeV electrons that are accelerated by lightning discharges.

In addition, Dr Rowland continues to develop instrumentation for the upcoming VISIONS sounding rocket mission, for which he is the PI (launch January 2012 from Poker Flat, AK), and which uses GSFC expertise in electric fields and energetic-neutral-atom imaging to study the mechanisms by which thermal ions gain more than two orders of magnitude in energy and achieve escape velocity, allowing them to reach high altitudes and populate the magnetosphere. Finally, Dr Rowland continued to develop electric field and plasma density instrumentation for an additional four sounding rocket payloads: two for the "Dynamo" rockets (PI: Rob Pfaff/674), launching from Wallops Flight Facility in June 2011, and two for the "Equatorial Vortex Experiment" (EVEX), launching from Kwajalein Atoll in September 2012.

Dr Rowland is active in mentoring activities, supervising one NASA postdoctoral fellow in 2009 and mentoring three undergraduate students at GSFC as they learned about spacecraft design and engineering. In 2010 Dr Rowland served on two NASA review panels, as well as the Sounding Rocket Working Group and the Geospace Management Operations Working Group.

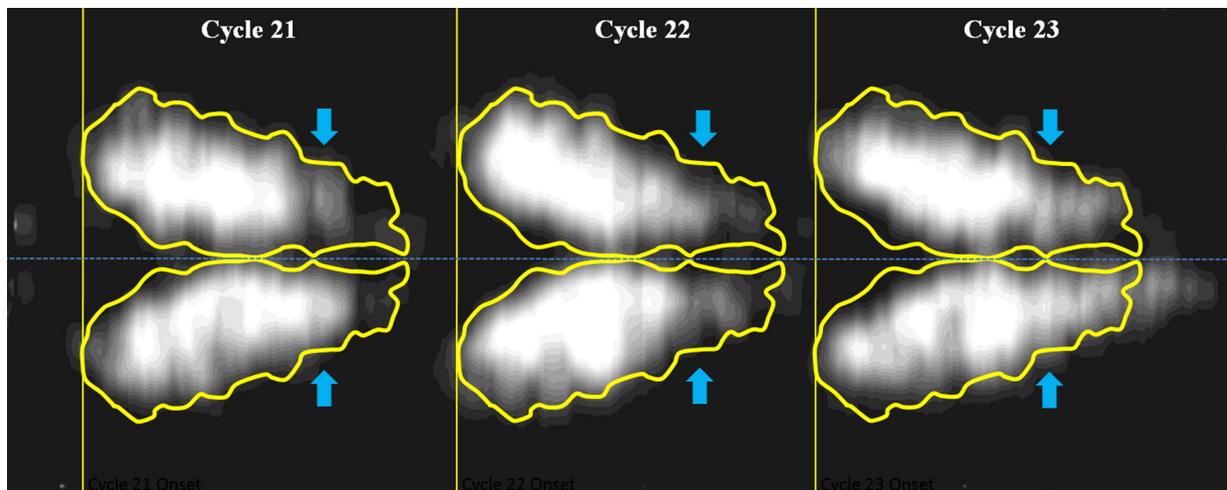


Firefly calibration data, showing instrument response to γ -rays (blue) and electrons (red)

Julia L. R. Saba



Dr Saba is a 25-year member of the GSFC solar group. With a BS in physics from the UMCP, she worked in the GSFC Laboratory for High-Energy Astrophysics X-ray Group's instrument lab under a cooperative LHEA-UMCP program before seeking post-graduate degrees at UMCP, while researching X-ray binaries at GSFC as part of her PhD work. She joined the SMM X-ray Polychromator team in 1984 and became deputy PI in 1988. She worked at the Solar Data Analysis Center and joined the SOHO MDI instrument operations team. Her solar research interests include active region and flare dynamics and coronal plasma diagnostics; she has been PI of four NASA grants. She is now a senior scientist at SP Systems, Inc., consulting for HSD. She was a scientific editor for the previous HSD Scientific Highlights reports.



The “Butterfly Diagram” of strong-field ($B > 25$ G) magnetic flux shows low-latitude Cycle 23 flux persisted in the South long after it had faded in the North. We speculate that the persistence of strong old-cycle flux in Cycle 23 may have inhibited the onset of Cycle 24 explaining the extended solar minimum.

This past year, she has continued working with Dr Keith Strong on tracking the solar activity cycle via the evolution of surface magnetic patterns. Julia and Keith made the first accurate prediction of the *onset* (i.e., the rapid global blossoming) of solar cycle 24, which occurred in mid-December 2009, 18 months in advance. At the SOHO 23 meeting on *Understanding a Peculiar Solar Minimum*—held in Northeast Harbor, Maine, in September 2009—they presented two posters and an invited talk, showing that the increasing phase lag between activity in the two hemispheres may provide an important clue to the delayed onset of Cycle 24. They also organized a special session at the 2010 SHINE meeting in Santa Fe entitled “Understanding and Predicting the Solar Cycle,” and have been asked for a reprise next year.

Miho (Hasegawa) Saito



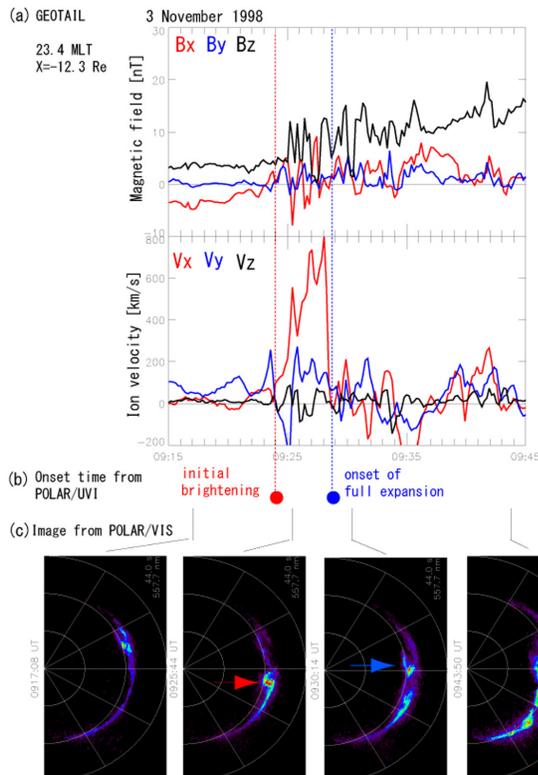
Dr Miho Saito was born in Tokyo, Japan. She obtained her BS in physics at Nagoya University, Japan, and her MSc and PhD from the University of Tokyo in 2008. She worked at the National Central University, Taiwan, R. O. C., for a year and a half before joining the heliophysics group at GSFC in July 2010.

Her research interests include theory and observations of explosive phenomena in plasma, namely, magnetosphere, plasma sheet, waves, instabilities, aurora, field-aligned currents, and current sheet, as well as technology for measurement of space phenomena, particularly by spacecraft. She has analyzed data from Geotail, Polar, and THEMIS.

It may be surprising and pity that Earth’s aurora that has been extensively studied in past and has been known to exhibit explosive features having various structures has been poorly understood in terms of plasma physics.

Miho is developing a new methodology for analyzing spacecraft data by using multi-instrument and multipoint in situ measurements.

Working with Dr Donald Fairfield and Dr Guan Le, she is trying to find better and simpler explanation for complicated explosive space plasma phenomena observed in the magnetotail and its relationship to the ionosphere.



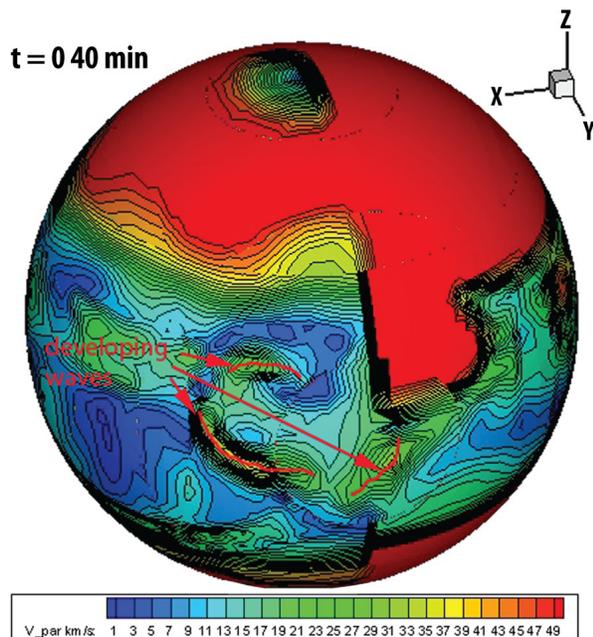
Plasma sheet behaviors during auroral substorm expansion

Joachim Schmidt

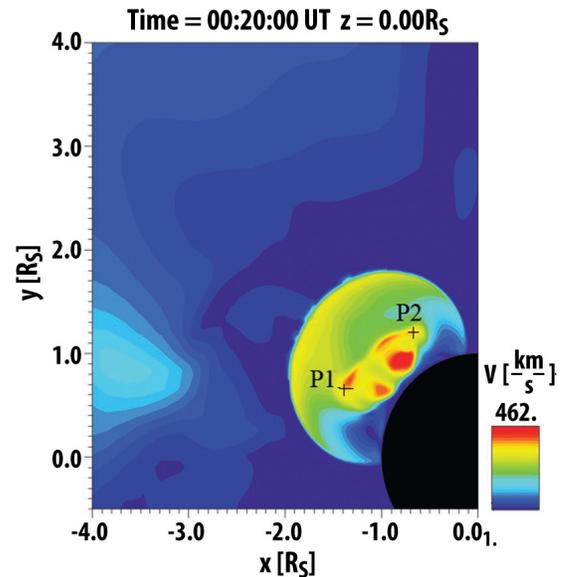


Dr Joachim Schmidt was born in Ravensburg, Baden-Wuerttemberg, Germany. He studied physics at the University of Goettingen, Germany, obtaining a diploma degree in theoretical physics. He received his PhD at the Max Planck Institute for Solar System Research in Katlenburg-Lindau, Germany, in 1993. Since then, he was a visiting scientist at the Observatory of Arcetri in Florence, Italy, the Institute for Experimental and Applied Physics in Kiel, Germany, the Imperial College of Science, Technology and Medicine in London, Great Britain, and the International University of Bremen, Germany.

Joachim joined GSFC in 2007 in the NASA senior guest researcher program, and continued as a research scholar at Catholic University of America since 2009. His research work at GSFC includes the numerical investigation of radio emission in radio bursts driven by CME shock waves in 2½ and 3 dimensions, the 3D MHD simulation of Extreme Ultraviolet Waves (EIT) on the Sun, and the 3D MHD simulation of expanding coronal loops in the solar corona.



A simulated EIT wave as velocity enhancements of the plasma velocity parallel to the solar surface, V_{par} . The wave shows up at the fringe of an elliptical area, which includes an active region as the launching site of a CME, triggering the EIT wave.



Simulated expanding loop in the solar corona. The image shows plasma streaming away from the loop (in a half-moon shape) and contributing to the formation and the heating of the slow solar wind. The red, elongated areas peaking at point P1 and P2 are fast magneto-sonic wave packages within the center area of the loop propagating toward the foot points of the loop, which store wave energy within the loop.

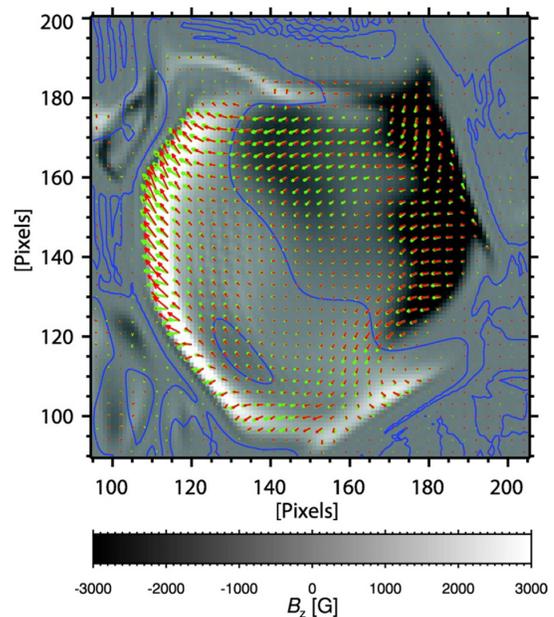
Peter W. Schuck



Dr Peter Schuck was born in Oradell NJ. He received a BS in engineering physics from Rensselaer Polytechnic Institute in 1991, and he holds a MEng, MS, and PhD degrees in applied and engineering physics from Cornell University. He was a National Research Council postdoctoral fellow at the Naval Research Laboratory (NRL) and joined the NRL as a Federal scientist in 2004. In May 2009 Peter joined GSFC as a Research Astrophysicist in the Space Weather Laboratory. Peter is the PI of several NASA Living with a Star (LWS) and Heliospheric Guest Investigator (HGI) programs. His research involves combining theory, data analysis, and statistical methods in novel ways to constrain models for triggering and driving solar coronal mass ejections—the largest explosions in the solar atmosphere.

One technique developed through LWS programs, called the “Differential Affine Velocity Estimator for Vector Magnetograms” (DAVE4VM), determines photospheric plasma velocities from a sequence of vector magnetograms. These plasma velocities may be used to determine the magnetic energy flux through the photosphere and constrain the coronal energy budget. This method will play an essential role in analyzing data from the HMI aboard the SDO.

Another method developed involves analyzing Dopplergrams from the MDI aboard the SOHO. This technique was used to examine the plasma velocities in the photosphere during a CME which erupted at 11:30 UT on 2000 September 12. The observed low photospheric velocities limit the energy that can be provided by the photosphere during a CME, and rule out a class of theories proposed for driving eruptions via concomitant energy flux through the photosphere.



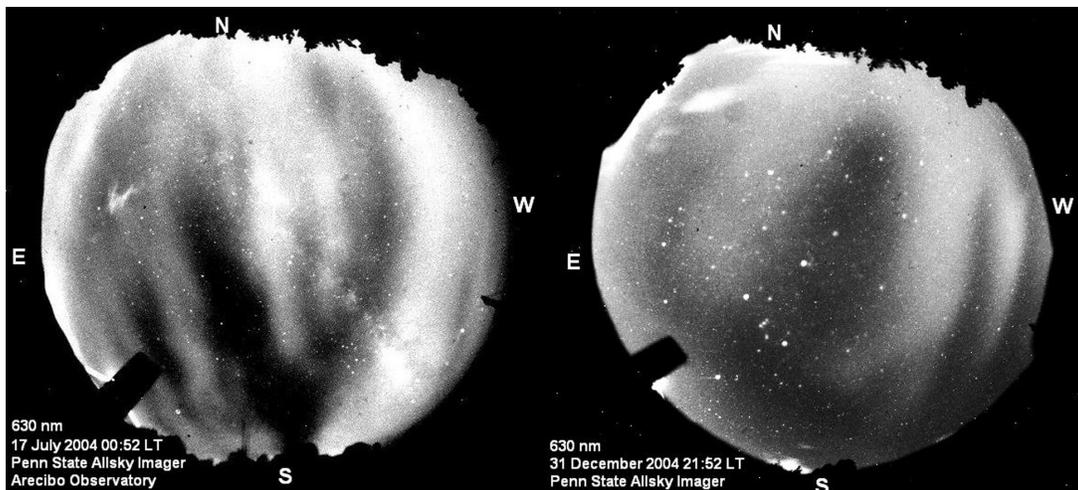
Velocity-inversion algorithm test with a synthetic magnetogram from an MHD simulation. The gray scale indicates the vertical magnetic field intensity and the blue lines indicate neutral lines. The red arrows show the inverted flux transport vectors uB_z determined by DAVE4VM technique plotted over the MHD simulation's “ground truth” flux transport vectors UB_z (green arrows).

Ilgın Seker



Dr Ilgın Seker completed his major in electrical engineering and minor in physics at METU in Ankara, Turkey. He obtained his MS and PhD degrees in electrical engineering from the Pennsylvania State University in 2006 and 2009, respectively. During his PhD, Ilgın was responsible for the Penn State Allsky Imager at Arecibo Observatory in Puerto Rico, and studied the airglow signatures of ionospheric irregularities—particularly MSTIDs. He has joined the GSFC Geospace Physics Laboratory in 2009 as a NASA Postdoctoral Program Fellow and has been working with Dr Shing Fung.

In FY2010, Ilgın has worked with Dr Fung and a summer intern on the relation of ionospheric irregularities with the magnetosphere. After statistically comparing the occurrences of airglow events in the nighttime, mid-latitude F-region (such as MSTIDs and spread-F plumes) with various geomagnetic state parameters (such as Kp, Dst, AE, and solar wind parameters), he has shown that the mid-latitude plumes and MSTIDs usually occur during high and low geomagnetic activity, respectively. The results are useful for understanding under what conditions these irregularities—which adversely affect satellite communications,— are triggered which is important for forecasting these events.



Two all-sky images from Arecibo Observatory showing a spread-F plume (left panel) reaching mid-latitudes during a geomagnetic storm, and MSTID bands (right panel) that usually occur when the geomagnetic activity is low.

Albert Y. Shih



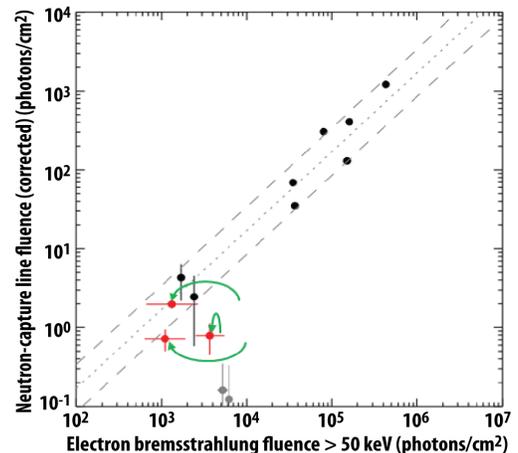
Dr Albert Shih was born and raised in Southern California. He obtained his BSc in physics and mathematics from the California Institute of Technology, and his PhD in physics from the University of California, Berkeley. He was a GSFC GSRP fellow from 2004 to 2007, and then he started at GSFC as an NPP fellow in 2009. In 2010, he was hired by GSFC as a research astrophysicist in the Solar Physics Laboratory.

Albert continues to primarily study ion acceleration in solar flares, largely through γ -ray spectroscopy and imaging using RHESSI. His knowledge of the RHESSI hardware was also useful to him as part of the team who carefully recovered RHESSI from an anomalous shutdown in the spring of 2010. He was also involved in a variety of proposals submitted in FY2010 for new balloon instruments, new spacecraft instruments, and new instrument development.

For the 10th RHESSI Workshop held in Annapolis, MD, Albert served both as part of the local organizing committee and as the leader of the “Gamma Rays and Ions” group. The workshop gathered over 50 scientists from around the globe to discuss RHESSI-related science as well as future directions for high-energy solar science.

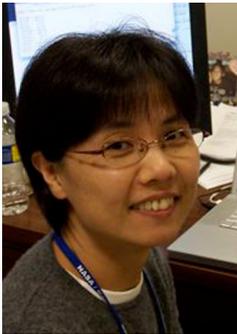
Albert is a co-investigator on GRIPS, a NASA Low-Cost-Access-to-Space balloon mission, being led by the University of California, Berkeley. GRIPS will use γ -ray observations to address unanswered questions about ion and electron acceleration in flares. GRIPS combines a new germanium detector technology with a novel γ -ray imaging design to provide a near-optimal combination of high-resolution γ -ray imaging, spectroscopy, and polarimetry, with an unparalleled γ -ray angular resolution of 12.5 arcseconds.

Albert is a member of the SDC, focusing on issues related to postdoc recruitment and community. He is also the vice president of GSFC’s Employees Welfare Association postdoctoral club called NGAPS.



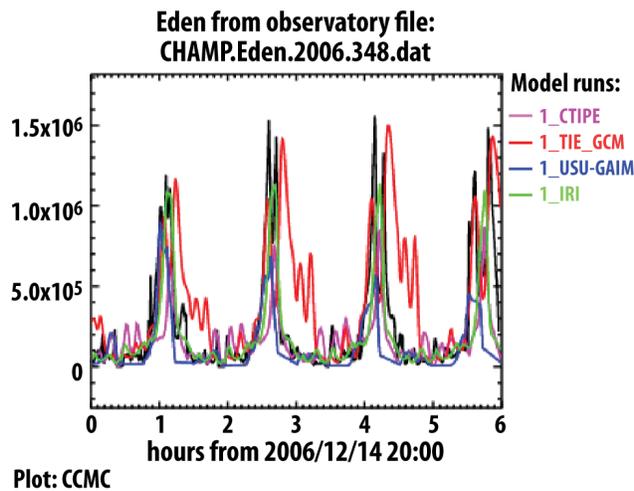
There may be two populations of flare-accelerated >50 keV electrons: one that is proportional to ~ 20 MeV ions, and a soft, low-energy population without such association. This correlation shows the improvement when the emission from the latter population is subtracted out (depicted by the green arrows, to the red points, showing the amount of shift).

Ja Soon Shim

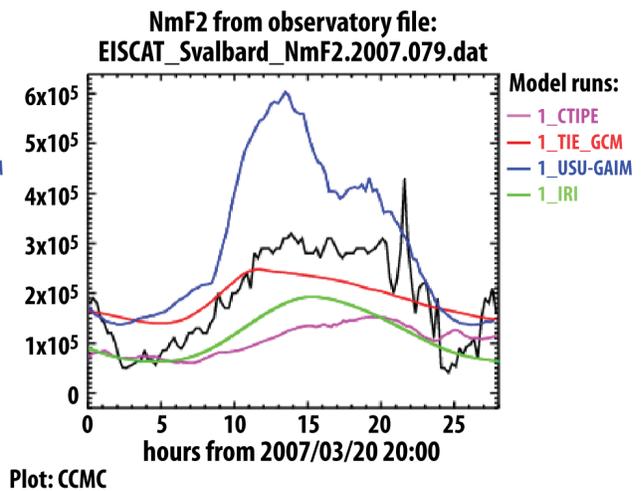


Dr Ja Soon Shim received her MS and PhD in particle physics from Seoul National University, Korea, in 1987 and 1993, respectively. She obtained her PhD in space physics from Utah State University in 2009. In September 2009, Ja Soon joined the GSFC Earth Sciences and Technology Center operated at GSFC as a research associate. She has been working in the Community Coordinate Modeling Center (CCMC) at GSFC.

Ja Soon has been working on an ionospheric model validation study, which includes CEDAR Electrodynamics Thermosphere Ionosphere (ETI) modeling challenge. For the challenge, simulations are carried out for nine selected events and for five physical parameters by using multiple ionospheric models hosted at CCMC. The analysis of model results are performed by comparing with observational data—such as electron density obtained from the CHAMP satellite, F2-layer peak electron density (NmF2) and peak height (hmF2) obtained from Incoherent Scatter Radar (ISRs). The CEDAR ETI Challenge will be expanded to include TEC, Joule heat, and a yearlong climatological study (2007 March to 2008 March).



Electron density at the CHAMP orbit obtained from the CHAMP satellite measurements (black) and four ionospheric model (CTIPE, TIE-GCM, USU-GAIM and IRI) outputs (color) for 14 December 2006



F2-layer peak electron density obtained from EISCAT Svalbard Observatory (black) and four ionospheric model (CTIPE, TIE-GCM, USU-GAIM and IRI) runs for 20–21 March 2007 (in color)

David Gary Sibeck



Dr David Sibeck is a magnetospheric physicist in the Space Weather Laboratory (Code 674) at GSFC. After receiving a PhD from UCLA in 1984, he was employed at The Johns Hopkins University Applied physics Laboratory (JHU/APL) from 1985 to 2002. With the exception of a year when he was detailed to NASA Headquarters, he has worked at GSFC since 2002.

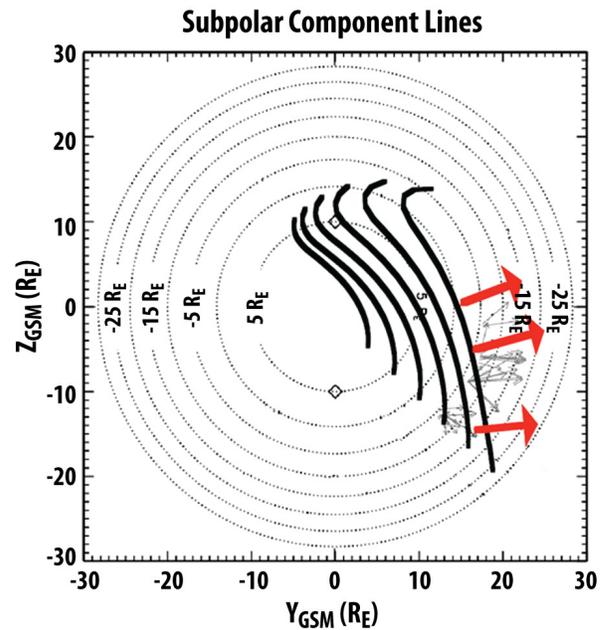
As project scientist, Dr Sibeck leads efforts to publicize science discoveries from the THEMIS mission. As mission scientist, he advises NASA Headquarters, GSFC, and JHU/APL on science requirements for RBSP. He is president-elect of the steering committee for the NSF’s Geospace Environment Modeling program.

He works closely with researchers at Solana Scientific, Sciberquest, the University of Maryland, the University of Alaska, JHU/APL, the National Space Research Institute in Brazil, as well as the University of Saint Petersburg in Russia.

Dr Sibeck serves on the advisory committee for ESA’s Cluster Active Archive. During 2010, he was the heliospherics editor for *Advances in Space Physics*, guest editor for *The Journal of Atmospheric and Solar-Terrestrial Physics*, and corresponding editor for heliophysics at *Eos*. He frequently handles calls to GSFC from the press, radio, and television on heliophysics. Each summer he lectures visiting high school teachers on the aurora; and at each fall AGU he presents a lively lecture on the aurora at the NASA booth. He runs the dayside science study group at GSFC, which meets on Mondays at noon.

Dr Sibeck is presently studying the structure of the magnetosheath and the characteristics of flux transfer events, two phenomena that may control the nature of the solar wind-magnetosphere interaction. He works closely with Mike Collier on instrument proposals to image the magnetosheath.

Dr Sibeck submitted 14 proposals submitted in 2010 and a 15th for THEMIS/ARTEMIS as an extended mission, and he published 7 papers.



John B. Sigwarth



Dr John B. Sigwarth serves as the senior scientist for technology advancement in HSD at GSFC where he leads the efforts for technology development in the division. He also serves as the deputy project scientist for the TIMED and AIM spacecraft missions. Dr Sigwarth received his BS, MS and PhD degrees from The University of Iowa in 1983, 1988, and 1989, respectively. He has been employed with GSFC for over six years.

Dr Sigwarth is the principal investigator leading the effort for a new camera to remotely sense the temperature of Earth's uppermost region of the atmosphere or 'thermosphere.' This new camera, the Thermospheric Temperature Imager (TTI), is being developed in collaboration with the United States Naval Academy.

Because of this collaboration, the TTI has been included as one of the experiments on the Department of Defense (DoD) Space Experiment Review Board (SERB) list for fiscal years 2007–2009. The TTI instrument was delivered and integrated onto the FASTSat spacecraft in September 2009. Since delivery, the TTI has supported and has successfully passed mission-level qualification tests. These tests included mission-level vibration, thermal vacuum, electromagnetic interference and electromagnetic susceptibility tests. As a result, the TTI was scheduled to fly in November 2010 on the FASTSat spacecraft in the DoD's Space Test Program.

Dr Sigwarth's research interests include the conjugate nature of the northern and southern auroras; the impacts of geomagnetic storms on the atomic oxygen and molecular nitrogen composition of the thermosphere; the driving of the aurora by sharp increases in the dynamic pressure in the solar wind impacting the magnetosphere; the coupling efficiency of energy from the solar wind to the magnetosphere as a function of the state of the solar wind; and the use of global auroral images to retrieve the energy deposition by auroral particles precipitating into the ionosphere. Dr Sigwarth has authored or co-authored 81 papers for publication and 170 presentations at scientific conferences.



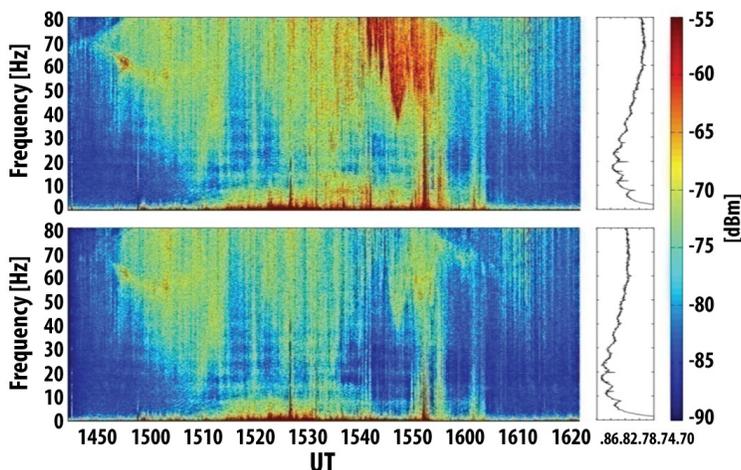
The Thermospheric Temperature Imager was delivered and integrated with the FASTSat spacecraft in September 2009 and will be launched in November 2010 as part of the Department of Defense Space Test Program.

Fernando Simões



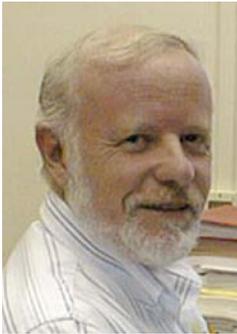
Dr Fernando Simões was born in Coimbra, Portugal, and earned a BSc and MSc from Instituto Superior Técnico in Lisbon, Portugal, and a PhD from Université Pierre et Marie Curie (Paris VI) in Paris, France. He previously worked in Australia, Austria, France, Portugal, and at the European Space Agency in The Netherlands. His background covers theoretical and experimental physics; he worked in different fields, namely optoelectronics (lidar applications and solid-state lasers), materials science (micromachining and superconductors), astrophysics (neutron stars), planetary science (wave propagation and atmospheric electricity), and space instrumentation (mutual impedance and relaxation probes). The outcome of those activities includes prototypes, papers, and international patents.

Fernando joined the Space Weather Laboratory (Code 674) in October 2009 as an NPP fellow (ORAU) and is working with Dr Pfaff in C/NOFS data analysis investigating tropospheric-ionospheric coupling mechanisms. He is analyzing AC electric and magnetic field data from the Vector Electric Field Instrument (VEFI) to study waves in plasma and low-frequency electromagnetic wave propagation in the surface-ionosphere cavity. Unexpected identification of Schumann resonance and ionospheric Alfvén resonator signatures onboard C/NOFS implies significant model revision of ELF wave propagation in the ionosphere. The former is suitable for troposphere-ionosphere electromagnetic-coupling research; the latter offers a new means for investigating ionosphere dynamics and inferring electron and ion density profiles. Experts in the field have considered the detection of Schumann resonances onboard C/NOFS to be the most important result in the subject in decades. Since the new C/NOFS results are also useful in comparative planetology—namely for the investigation of atmospheric electricity and wave propagation in Mars, Titan, and the gas giants—Fernando is also involved in planetary science studies. Using the intriguing Schumann resonance signatures detected onboard C/NOFS, he has been assessing innovative remote-sensing techniques for the investigation of planetary atmospheric electricity.



ELF electric field recorded by VEFI onboard C/NOFS during one orbit in 2008 May 31. (left) Spectrogram of the (top) vertical and (bottom) horizontal components; (right) average electric field amplitude integrated all through the orbit. The fuzzy, horizontal lines in the spectrograms correspond to Schumann resonance modes, whose peaks are best seen in the integrated panels on the right.

Edward C. Sittler Jr.

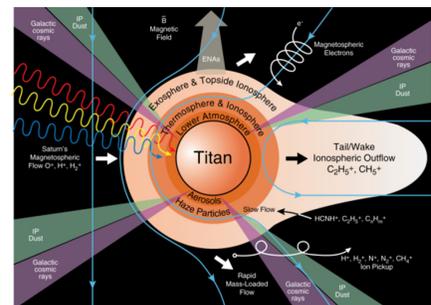


Dr Edward Sittler joined GSFC as a National Research Council Postdoctoral Associate in 1978, after which he became an astrophysicist in the GSFC’s Laboratory for Extraterrestrial Physics (LEP) in 1980 and is now in the Heliophysics Geospace Science Laboratory. He received his BS from Hofstra University in 1972 where he graduated Magna Cum Laude with honors in physics. He received his PhD in physics from MIT in 1978. He has contributed substantially to the understanding and observation of interplanetary and magnetospheric plasmas—through both instrument development and the interpretation of the data.

Dr Sittler is a Voyager 1 and 2 plasma instrument Co-I dating back to the early 1980s, and led or contributed to many papers detailing the plasma environments of the solar wind and the planetary magnetospheres of Jupiter, Saturn, Uranus and Neptune. He was a member of the original Cassini Science Definition Team in the mid-1980s. He is a Cassini Co-I for the Cassini Plasma Spectrometer (CAPS) Experiment. As CAPS Co-I he has (1) provided flight hardware and software for the CAPS ion mass spectrometer (IMS), (2) led the calibration of the CAPS IMS prototype and flight models at GSFC, and (3) leads the CAPS science at GSFC. As PI, he has led the development of a Living with a Star 3D IMS at GSFC, developed a nadir-viewing capability for inner heliosphere missions, and was Study Scientist for the Solar Probe STDT. Most recently he was a member of the Titan Saturn System Mission (TSSM) committee and is PI for the development of an Ion Mass Spectrometer (IMS) for the flagship mission to Europa under the Astrobiology Instrument Development Program (ASTID).

Dr Sittler has also been PI of numerous IRADs for a High Precision Electric Gate (HPEG) for planetary ionosphere missions and the “Radiation Model of Magnetosphere IMS and INMS for Europa”. The HPEG has the potential for achieving mass resolving power $M/\Delta M \sim 10,000$. The ASTID IMS is designed to achieve minor ion detection capabilities \sim ppm at Europa in a high-radiation environment.

This past year Dr Sittler has been investigating the astrobiological potential of Saturn’s moon Titan where, fullerenes-closed carbon shells (C60 and C70)—may be forming in its ionosphere, trapping magnetosphere oxygen ions from Enceladus and condensing into aerosols with PAHs and PAHNs. These aerosols eventually fall onto Titan’s surface forming a thin veneer of tholins. Cosmic ray bombardment penetrating down to the surface can result in exobiological processes and formation of amino acids. These same processes are now becoming known to occur in molecular clouds and nebulae; he is lead author on a paper discussing the synergism between Saturn, Enceladus, and Titan leading to these exobiological processes. This has resulted in a NASA press release. Dr Sittler was also lead author on a chapter in the book “Titan From Cassini-Huygens,” which discussed Titan’s induced magnetosphere and energy deposition to its upper atmosphere.



Various forms of energy deposition to Titan’s atmosphere and formation of induced magnetosphere

James A. Slavin

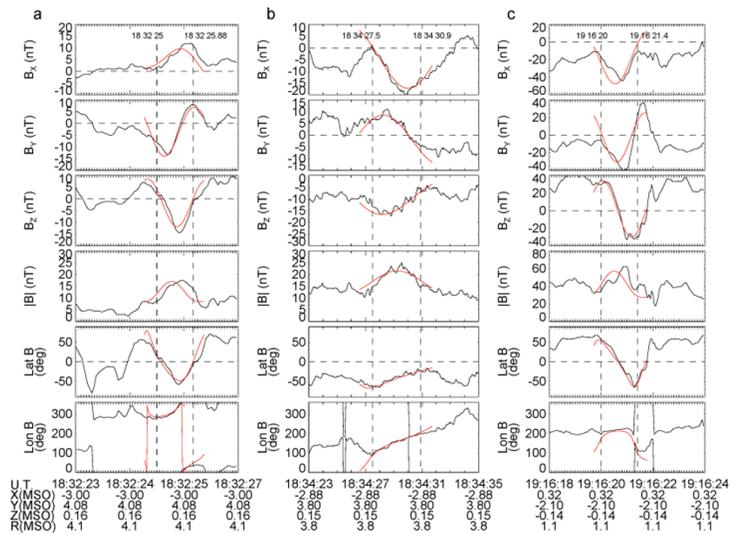


Dr James A. Slavin is the Director of HSD. Although he spends a lot of his time on administrative and supervisory matters, he greatly enjoys the many opportunities that HSD affords him to work with all of the people and their highly varied skills and backgrounds that have come together to make NASA's Heliophysics program the great success that it is.

In addition to collaborating with senior members of the HSD staff, Dr Slavin conducts magnetospheric physics research with a number of more junior civil servants and post-doctoral scientists. He is especially active in the MESSENGER and Magnetospheric MultiScale missions, but his research concerning reconnection and magnetotail dynamics also makes use of measurements returned by the Space Technology 5, Cassini, and THEMIS missions. Dr Slavin also spends one day a month at the University of Michigan co-advising a NASA cooperative program graduate student. Weather permitting, he is generally found after work on the GSFC tennis courts playing with other HSD enthusiasts.

FY 2010 was a strong year not only for HSD (see Preface) but also for Dr Slavin's research, with 16 new journal articles being published, including 2 first-author papers. In particular, the MESSENGER magnetic field measurements at Mercury continue to indicate that the effects of reconnection between the interplanetary magnetic field and planetary magnetic fields increase in intensity and importance with decreasing distance from the Sun. This new discovery is reflected in the MESSENGER measurements, with Mercury possessing the most dynamic magnetosphere in the solar system.

The figure depicts constant- α force-free flux rope model fits (red trace) to the MESSENGER magnetic field measurements (black trace) from a recently published analysis of the Mercury flux transfer events observed by MESSENGER conducted by Dr Slavin, Dr Ronald Lepping (674/Emeritus), and others at HSD and elsewhere. The results indicate that these discrete magnetic field flux transfers from the dayside to nightside magnetosphere are at least an order of magnitude larger in relative amplitude at Mercury than they are Earth. Indeed, in some instances a single flux transfer event may transfer enough energy to power a magnetospheric substorm at Mercury as opposed to tens of such events being required at Earth.



O. C. St. Cyr

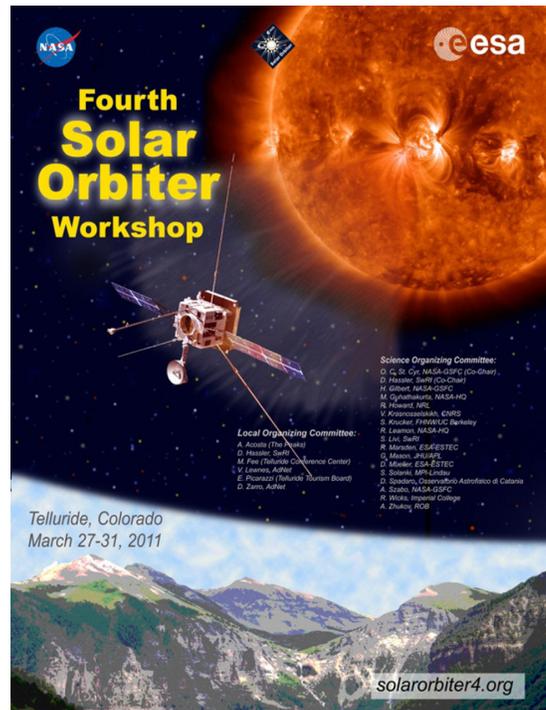


Chris St. Cyr has been a solar and space weather researcher, an operations scientist, and a Project Scientist at GSFC since 1984. Over the years he has worked as a “.edu” and “.com” contractor, and he has been a civil servant since 2002. He is a VietNam-era veteran, and he has a BS in astrophysics from the University of Oklahoma and a PhD in astronomy from the University of Florida.

Presently, St. Cyr continues to serve as Senior Project Scientist for Heliophysics missions in development, and as NASA Project Scientist for Solar Orbiter—a joint ESA/NASA mission to explore the Sun, its connection to the environment of the inner solar system, and how it controls the heliosphere. Over the past year he has been Chair of the NASA Space Weather Working Group, under the aegis of NASA Headquarter’s Office of the Chief Engineer. He was Co-Chair for the 2009 Community Roadmap

strategic planning activity for the Heliophysics Division. He frequently serves on review panels and briefs advisory groups both internal and external to NASA.

St. Cyr’s research interests include the initiation and propagation of solar coronal mass ejections; testing new instrumental techniques at total solar eclipses; performing solar cycle studies of the Sun’s white-light corona; studying Sun-grazing comets, and quantifying economic impacts of space weather in electric power grids. He is the Lead of a Living With a Star (LWS) Targeted Research and Technology (TR&T) Focus Science Team (FST) studying the inner heliosphere. The FST research effort is focused on the propagation of interplanetary shocks in the inner heliosphere and the generation of solar energetic particle events.



St. Cyr is Co-Chair for the Fourth Solar Orbiter Workshop, to be held in March 2011 in Telluride, CO.

Keith Strong



Dr Keith Strong was born in Torquay, Devonshire, GB. He obtained his BSc in astronomy from University College, London, and his PhD from Mullard Space Science Laboratory in 1979. He worked at LMATC for nearly 30 years, starting as a data analyst and eventually ending up as the senior manager of the two space science departments where he directed their IRAD programs and helped win the Yohkoh SXT, TRACE, GOES-M SXI, Hinode XRT, Triana EPIC, GOES-R GLM & SUVI, and James Webb NIRCcam instruments. Keith was PI on the Solar Max XRP instrument. He has been working at GSFC for 3 years since retiring.

FY 2010 started off as the previous year, namely with Keith and Julia Saba working on the FY2009 HSD annual report, which took about 4 months of their time. The 2009 edition included a digital version of the report on the HSD Web site and was distributed on flash drives, which turned out to be a great success. The report seemed well received by its target audiences.

On the science side, Keith continued working on solar cycle forecasting with Julia, and their efforts were rewarded when they made the first accurate prediction of the onset of cycle 24 (which occurred in mid-December 2009) and subsequently predicted successfully the next outburst of activity in July/August 2010.

Keith and Julia teamed up to propose, organize, attend, and report on a special session at the 2010 SHINE meeting in Santa Fe, NM, entitled “Understanding and Predicting the Solar Cycle.” The session experimented with a discussion-only format, which turned out to be very successful and may be a template for future sessions. Keith also attended the Space Weather Workshop in Boulder to give a poster on solar cycle prediction and participate in a panel discussion on developing the space weather business. He attended the SOHO 23 meeting in Northeast Harbor, ME.

Keith and Julia have also been developing a novel approach to E/PO by using social networking games to teach the science and history of space science.



The onset of Cycle 23 was in August 1997 whereas Cycle 24’s onset was in December 2009, which makes the length of Cycle 23 about 12.3 years the longest cycle for nearly a century. Cycle 23 seemed to proceed normally for its first half, but about 5 years ago, there was a divergence in the evolution of the northern and southern hemispheres. The north continued to decline as predicted but the south sustained a much higher level of activity than expected which may be an important clue to the reason for the extend length of Cycle 23.

Errol J. Summerlin



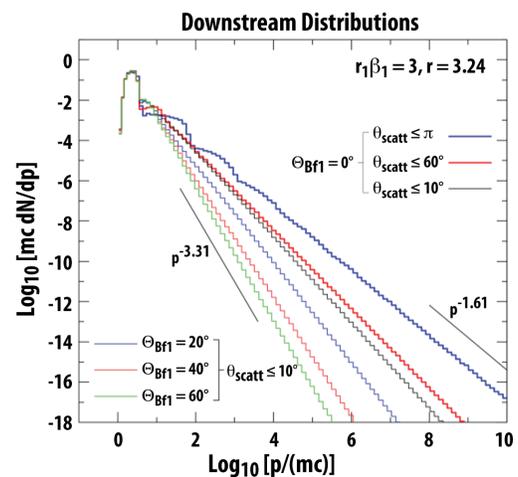
Dr Errol Summerlin earned his BS at Georgia Tech and his PhD in physics from Rice University. His PhD work focused on modeling particle acceleration at shocks in both heliospheric and astrophysical environments. He came to GSFC immediately after obtaining his PhD in July of 2009.

In FY2010, Errol began submitting proposals in his new position at GSFC. In total, he has been involved in four proposals (2 E/PO and 2 science) this fiscal year. In addition to a vigorous proposal campaign, Errol has also been an active member of the SDC. As part of this group, Errol has chosen to focus on support for young scientists and is working with the SPSO to develop a workshop that will help young scientists write better proposals and get their research programs off the ground.

In August, Errol traveled to Pasadena, CA, to take a crash course in mission design at JPL. The Planetary Science Summer School (PSSS) is a one-week program where the students work with the JPL Team X members to create a mission proposal for the Discovery program (a task that is normally done in about 3–6 months). At the end of the week, the students present their mission to a panel of experienced reviewers. Errol's team designed a mission to Io called OVID, which received the highest rating of any PSSS group to date.

Since January 2010, Errol has also been in charge of the HSD seminar. This position—which typically goes to the most junior scientist in the HSD—consists of arranging speakers, booking rooms, sending out announcement E-mails, updating and maintaining the seminar Web site, as well as arranging badges for U.S. citizens. So far this year, he has arranged and hosted over 50 seminars and received an award from the Director for his service.

Finally, Errol has also found time to do a little science. He attended the fall AGU and the SHINE conferences this year, giving an oral presentation at the former and poster presentation at the latter. His scientific work has focused on adding temporal and spatial constraints to the acceleration process in the simulation he worked on for his PhD. These constraints allow him to model the high-energy rollover in the power-law tail of energetic particle spectra at shocks. He has also worked on incorporating the effects of moving turbulent scattering centers in his simulation, which, when finished, should improve the modeling of the injection process at low energies. Finally, he is working on publishing a paper that will show that the canonical power-law index of -2.23 in relativistic shocks is, in fact, not canonical at all and depends critically upon turbulence and shock obliquity. This will be a follow-up to the paper where the preliminary results were published.



This figure shows the multitude of power-law indexes found by varying the shock obliquity and size of the scattering cone.

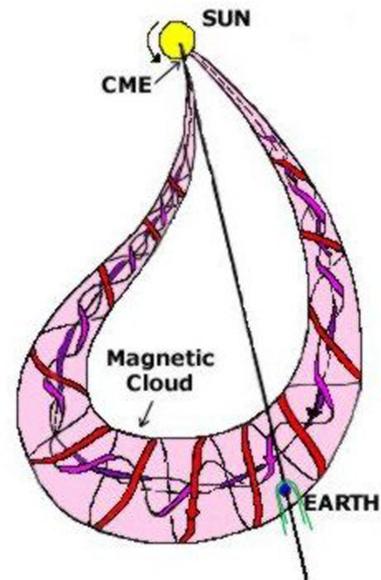
Adam Szabo



Dr Adam Szabo was born in Debrecen, Hungary. He obtained his BA in physics from the University of Chicago, and his PhD from the MIT in 1993. After a short post doctoral position at MIT, he moved to GSFC: first as an NRC fellow, then as a Hughes STX research scientist, and finally appointed as a NASA civil servant in 1997. He is currently the chief of the Heliospheric Physics Laboratory and serves as the Project Scientist for WIND and DSCOVR and as the Mission Scientist for the new Solar Probe Plus mission to the solar corona. Adam is also the principal investigator for the WIND Magnetic Field Investigation (MFI) and leads the Virtual Heliospheric Observatory (VHO) group that aims to make heliospheric data products independently usable by the scientific community.

Adam specializes in the study of heliospheric structures, such as interplanetary shocks, discontinuities, and ICMEs/magnetic clouds. In a recent study, he analyzed WIND magnetic field and energetic electron observations within magnetic clouds that are well fitted by a force-free, constant, alpha flux rope model. Adam showed that the 1 AU arrival time of the various energy electrons, which closely follow field lines, yield similar 2–4 AU field line lengths from the Sun as computed using the fitted magnetic cloud flux rope model at 1 AU, assuming magnetic flux and current conservation. This result is significant because it implies that ICMEs close to the Sun are not nearly as twisted as previously thought. Also, the work implies that the commonly accepted Lundquist geometry is unlikely to be correct for the entire length of the magnetic cloud flux ropes.

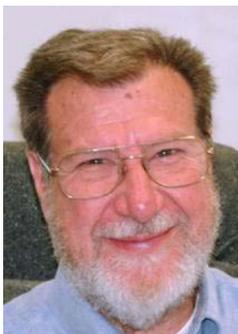
On the programmatic side of things, after the selection of the Solar Probe Plus instrument payload, Phase A activities are already in high gear. Adam is very involved in the definition of the level-1 science requirements of the mission and working out instrument accommodations on the spacecraft bus. The WIND mission just celebrated its 16th year in orbit and continues in good health, collecting continuous, high-quality solar wind measurements at the Earth’s L1 Lagrange point. For DSCOVR, formerly known as Triana, the Earth science instruments have been successfully refurbished and the process has begun to procure a longer, 7-m magnetometer boom to improve the accuracy of the magnetic field measurements.



[After Marubashi] Not to Scale

The conventional magnetic topology of a magnetic cloud has been shown to be incorrect.

Roger J. Thomas



Dr Roger Thomas is an internationally recognized expert on the design and scientific use of imaging EUV spectrographs. He created the optical designs for CDS/NIS on SOHO and EIS on Hinode, as well as for numerous sounding rocket instruments including SERTS, EUNIS, MOSES, SUMI, RAISE, VERIS, and UVSC, on each of which he serves as Co-I. He has been with GSFC since obtaining his PhD in astrophysics from the University of Michigan in 1970.

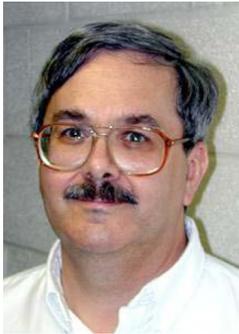
Dr Thomas has been the Orbiting Solar Observatory Project Scientist (1976–1983), the Study Scientist for the Solar Cycle and Dynamics mission (1978–1981), the Deputy Chief of NASA’s Solar and Heliospheric Physics Office (1983–1984), and the Deputy Project Scientist for the Orbiting Solar Laboratory mission (1990–1992). He has also been the science advisor for several NASA red teams monitoring the progress of solar-satellite missions such as TRACE, Hinode, and STEREO.

Dr Thomas is presently pursuing studies of spatially imaged, high-resolution, EUV spectra of coronal structures. Specific topics of interest include determination of elemental abundances and their possible variations, investigation of proposed coronal heating mechanisms, and quantitative characterizations of physical plasma conditions in different solar features.

He is actively involved in the design, ray-trace optimization, and fabrication of spaceflight optical systems—especially XUV imaging spectrographs using varied line-space gratings ruled on aspheric surfaces. He also leads the effort to obtain an absolute radiometric calibration for the EUNIS sounding rocket experiment, a key aspect of its scientific value. He has authored or coauthored more than 82 scientific publications in refereed journals, and at least 180 other scientific or technical papers.

In 2009, Dr Thomas received the prestigious NASA Exceptional Service Medal, and was a member of the EUNIS team that won a NASA Group Achievement Award. He retired in January 2010 after nearly 40 years of Federal civil service, but retains his presence in Heliophysics as a GSFC Emeritus.

William T. Thompson

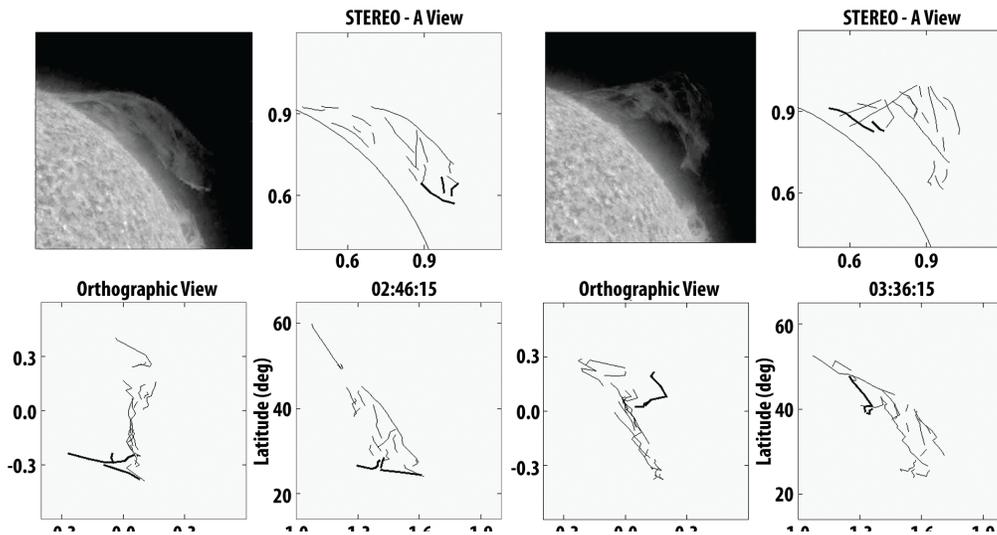


Dr Bill Thompson has been employed as a contractor at GSFC, supporting the Solar Physics Division, since 1984. He currently works for Adnet Systems, Inc. in the position of Senior Scientist. He received a Bachelor of Arts degree in physics and mathematics from the New College of the University of South Florida in 1974, and a PhD in astronomy from the University of Massachusetts in 1982. Between 1982 and 1984, he served as a lecturer in the Department of Physics and Astronomy at San Francisco State University.

Bill serves as the Chief Observer for the NASA Solar Terrestrial Relations Observatory (STEREO) mission. As such, he oversees the STEREO Science Center, which serves as the primary archive for the mission, and is the processing point for the STEREO space weather beacon data. As Chief Observer, he is also responsible for coordinating scientific activities between the STEREO instrument teams. Bill is also a member of the team operating the COR1 telescope aboard STEREO, and is responsible for characterizing the instrumental calibration. In addition, he serves on the IAU working group on the Flexible Image Transport System (FITS) standard.

Recently, Bill became involved in the detector development program for the SPICE instrument aboard Solar Orbiter. This detector is similar in many ways to the detector he helped develop for SOHO, but it uses more modern components. Bill is responsible for the detector characterization.

Bill's research areas include EUV spectroscopy, coronagraphy, stereo triangulation, and space weather monitoring. His work covers all phases of a mission from instrument development, calibration, software development, through mission operations and data analysis.



Two frames from the 3D reconstruction of an erupting prominence showing reconnection events

Paulo F. Uribe

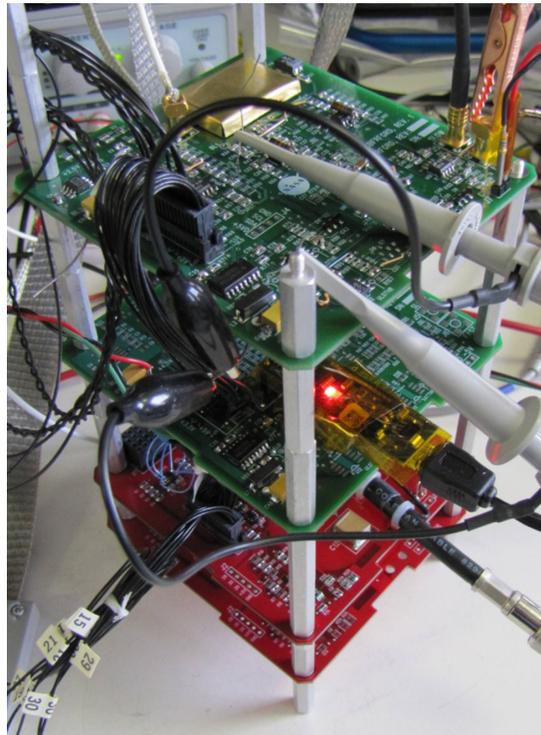


Mr. Uribe has been the lead engineer for several instruments developed for the Space Weather Laboratory (Code 674). He is currently in charge of the mission operations of the Vector Electric Field Investigation (VEFI): an instrument where Mr. Uribe designed the onboard computers, digital electronics, and flight software. VEFI has been operating for over two years.

More recently, Mr. Uribe worked on the Gamma-Ray Detector (GRD) for NSF's Firefly CubeSat. He mentored two University of Maryland students in the development of the high-voltage supply for a microchannel plate detector and designed the front-end analog electronics that perform the radiation pulse signal processing. Firefly will be launched next year and will determine the source of Terrestrial Gamma-ray Flashes (TGFs).

He is also leading the development of the electronics and flight software for two ionospheric research instruments. These instruments will perform electric field, electron density, magnetic field, and impedance measurements. They will be launched in the Dynamo sounding rockets from Wallops in 2011.

Firefly Gamma-ray Detector (top board) during testing of the charge sensitive preamplifier

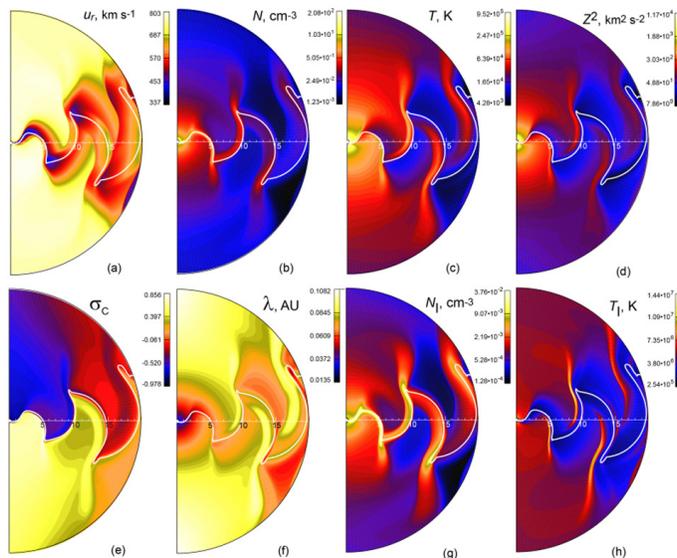


Arcadi V. Usmanov



Dr Arcadi V. Usmanov received his MS (1980) in geophysics and his PhD (1984) in mathematics and physics from the University of St. Petersburg, Russia. Arcadi worked for the Department of Geophysics of the University of St. Petersburg for nearly 20 years before coming to GSFC as a Senior NRC Associate in 2001. Since 2005, he has worked at GSFC as a Research Scientist under NASA and NSF grants to the University of Delaware.

Arcadi's main research topic is global modeling of the solar corona and solar wind. The focus over the last year was on the development of three-dimensional magnetohydrodynamic models of the outer heliosphere, taking into account the transport of turbulence and pickup protons as a separate fluid. The approach is based on a numerical solution of the coupled set of large-scale Reynolds-averaged solar wind equations and small-scale turbulence transport equations in the region from 0.3 to 100 AU. The pickup protons are assumed to be co-moving with the solar wind flow and described by separate mass and energy equations. The equations include the terms for energy transfer from pickup protons to solar wind protons and for the plasma heating by turbulent dissipation. The momentum equation contains a term that describes the loss of momentum by the solar wind flow due to the charge exchange with the interstellar neutral hydrogen and its photo-ionization. Initial results from this novel model were presented recently at the UAH Workshop 2010 in Nashville, TN. Scientific presentations were also given at the Fall AGU 2009 Meeting in San Francisco and the 9th Astrophysical Conference in Maui, HI.



Contour plots of computed solar wind parameters in the meridional plane from 0.3-20 AU for a source dipole field on the Sun tilted by 30 degrees. Plots show: radial velocity (a), density (b), proton temperature (c), turbulent energy (d), cross helicity (e), correlation length (f), pickup proton density (g), and pickup proton temperature (h). The heavy white line is the heliospheric current sheet.

Douglas M. Varney



Doug Varney joined GSFC in November 2009 as an Instrument Engineer contractor from Innovim, Inc. His BA is from the University of Maine and he also has degrees in electrical engineering technology and optics. In 2008, he graduated from James Cook University, Australia, with an MSc in astronomy and is currently working towards a PhD at the same institute. Dr Drake Deming, a Senior Scientist in the Solar System Exploration Division (Code 673), is his primary adviser here in the United States. His thesis topic pertains to late-type stars [K, M] in young open clusters and their magnetic and optical variability.

Doug works on the EUNIS sounding rocket, with other members of the Solar Physics Laboratory (Code 671). His primary task is FPGA (field programmable gate array) development and circuit design support for the new ICU (Instrument Computer Unit). Recently, he also began assisting the ONSET prototyping effort with Dr Joe Davila. This task simulates a boom with an occulting mechanism that will investigate the torque damping requirements in real-time.

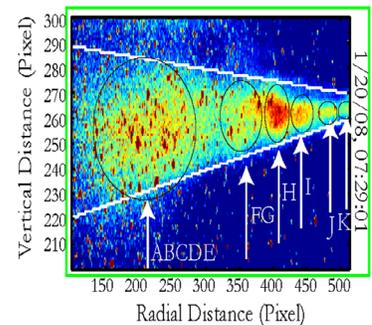
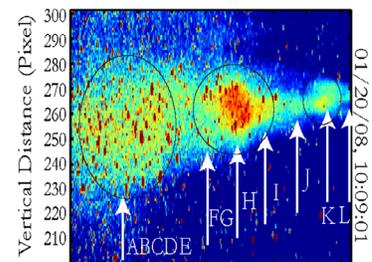
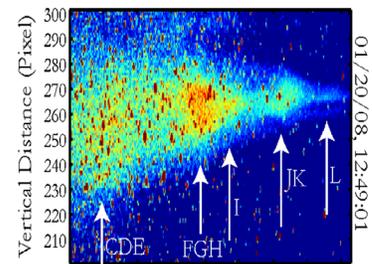
Nicholeen Viall



Dr Nicholeen Viall grew up near Seattle, Washington, and graduated with a BS degree in physics and astronomy from the University of Washington in 2004. Nicki earned a PhD in astronomy from Boston University in January 2010 for her work on periodic solar wind density structures before joining the Solar Physics Laboratory in January 2010 as an NPP Fellow working with Jim Klimchuk.

Nicki has continued her work on periodic density structures in the solar wind, identifying such structures for the first time in images of the solar wind. By analyzing white light images of the solar wind with a FOV between ~ 15 and 80 RS taken with the STEREO SECCHI HI1 instrument, she showed that periodic density structures are injected into the solar wind somewhere before ≈ 15 RS. They then advect with the ambient slow solar wind to 1 AU, where they are observed with in situ plasma measurements. This research provides important constraints on slow solar wind formation mechanisms, and characterizes an important form of solar wind variability. Periodic solar wind density structures are also important for Sun-Earth interactions, as they are known to drive globally coherent ULF waves in Earth's magnetosphere.

Using the new SDO/AIA data, Nicki is also investigating the heating of coronal loops in active regions on the Sun. She compared light curves of coronal loops in different AIA channels with predicted light curves of theoretical models of coronal heating, such as those of impulsive energy release on subresolution scales (or, nanoflare storm heating). Light curves in the different AIA channels reach their peak intensities with predictable orderings as a function of the properties of the heating. In particular, the observed time delay between light curves in different channels of certain coronal loops suggests that the energy release is impulsive, as opposed to quasi-steady. Ultimately, characterizing the heating of the coronal loops provides insight into coronal heating mechanisms.



A sequence of SECCHI HI1A images taken on January 19, 2008. Letters and arrows identify plasma enhancements; circles highlight periodic density enhancements. Time increase upwards, and the date and time of image are shown to the right. Color indicates the relative density, with red being the most dense.

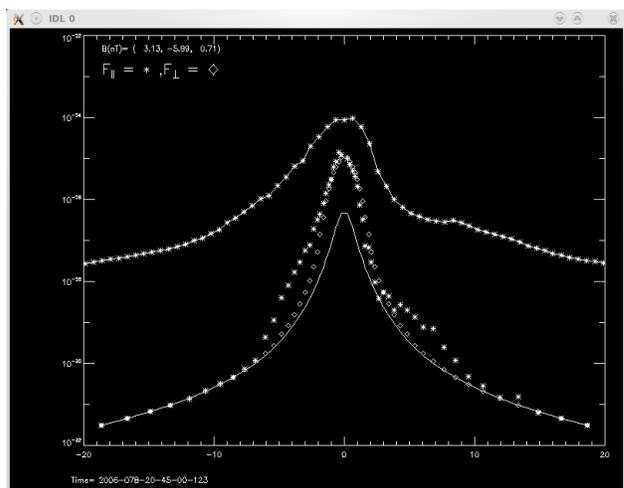
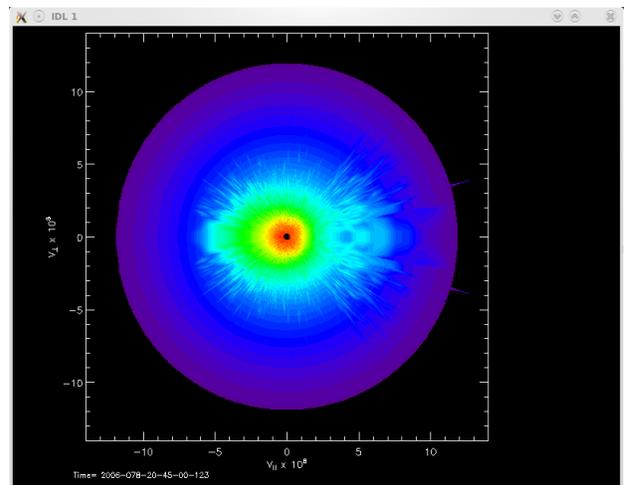
Adolfo F. Viñas



Dr Viñas was born in Puerto Rico. He obtained his BS and MS in physics from the University of Puerto Rico, and his PhD from the MIT in 1980. He has served as a research scientist in space plasma physics at GSFC since 1981. He has been Co-I on the electron spectrometer experiments of the ISEE VEIS, Wind SWE, Triana SWE, and Cluster PEACE satellites, and is currently in the MMS FPI mission.

Dr Viñas' research interests include the study of kinetic and MHD processes, particle transport, plasma instabilities, kinetic turbulence, shocks and discontinuities in the solar corona, solar wind and the magnetosphere. He developed a method based on the MHD conservation equations to characterize the geometrical and physical properties of shocks and discontinuities in the solar wind, which has been implemented into an analysis and visualization tool named SDAT.

Recently, Dr Viñas developed a new model-independent, spherical harmonic spectral method for the calculation and modeling of particle velocity distribution functions (VDFs) and the estimation of the full moments and anisotropies for fast and high angular and energy resolution plasma spectrometers. His most recent work using Cluster/PEACE electron measurements investigates the properties and characteristics of thermal and non-thermal three-dimensional velocity distributions of the core, halo and strahl electrons in the solar wind. An example of such non-thermal distributions is shown in the figure. Dr Viñas is the PI of an IRAD project named "RUSHMAPS: Real-time Uploadable Spherical Harmonic Moment Analysis for Particle Spectrometers" to develop a SpaceCube processor for onboard computing and analysis of in-flight particle spectrometers.



(Top) Full Cluster electron VDF in a coordinate system relative to the mean local magnetic field. (Bottom) Cuts of the same VDF for 0° and 90° pitch angles, and its associated reduced VDF.

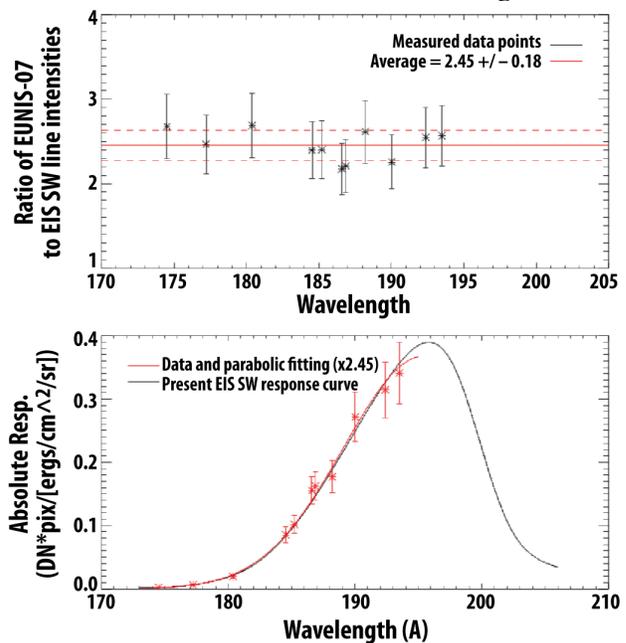
Tongjiang Wang



Dr Wang, solar physicist (Code 671), has been a research associate at CUA and working at GSFC since 2007. He received his PhD from the National Astronomical Observatories of China, Chinese Academy of Sciences, in 1998. He worked as a postdoctoral researcher at Kyoto University in Japan, the Max-Planck-Institute for Solar System Research in Germany, and Montana State University from 2000 to 2006. Dr Wang works on observational studies of waves, dynamics, and activity in the solar corona by analyzing space-based data from Yohkoh/SXT, TRACE, SOHO/EIT and SUMER, and Hinode/EIS to understand dynamics and heating of solar corona based on observations of various wave phenomena in coronal loops. He also works on absolute radiometric calibration of EUNIS (the EUV Normal-Incidence Spectrograph) by using data obtained from laboratory and solar observations.

In 2010, Dr Wang accomplished the absolute calibration of EUNIS-07 short wavelength (SW) channels based on solar observations and laboratory measurements in collaboration with other team members. By applying the obtained EUNIS-07 calibrations and the density- and temperature-insensitive line intensity ratio technique, the prelaunch (currently used) absolute responsivity of Hinode EIS (EUV Imaging Spectrometer) was updated. He also continued to study the propagating disturbances observed in coronal loops with Hinode/EIS by analyzing the spectra of multi-temperature lines to determine whether they are waves or flows, as well as their relationship.

Dr Wang attended the AAS/SPD meeting in Miami, Florida and 38th COSPAR Scientific Assembly in Bremen, Germany, and presented and contributed talk and posters.



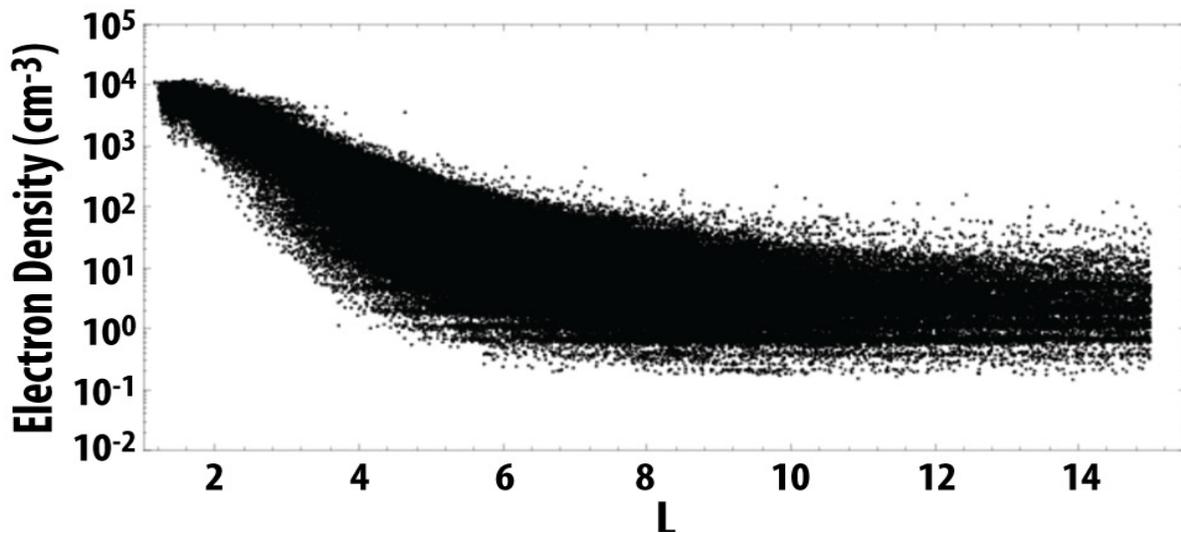
Absolute calibration update of Hinode/EIS with EUNIS 07. (Top) Ratio of measured line intensities of EUNIS-07 SW to EIS SW. (Bottom) Comparison between absolute response curves of EIS SW measured with EUNIS-07 and the one currently used, where the measured one has been scaled by a factor of 2.45.

Yongli Wang



Dr Yongli Wang was born in Jiaohe, Jilin, China. Yongli obtained his BSc from Peking University, Beijing, in 1995, and his PhD from the University of California at Los Angeles in 2003. He worked at Los Alamos National Laboratory as a postdoctoral fellow for two years and four months, and since 2006, he has been working at GSFC as a collaborating scientist.

In 2010, Yongli has been Principal Investigator for two NASA projects and Co-Investigator for four NASA and NSF projects, as well as contributing to Moon- and Vesta-related scientific research. He and his team have finished the first automatic IMAGE electron density database with full manual corrections, and are building the largest magnetopause crossing, bow shock crossing, magnetosheath, and flux transfer event database. Yongli is also building the next-generation magnetopause, bow shock, and magnetosheath empirical models, as well as new scientific data visualization, analysis, and management infrastructure and tools.



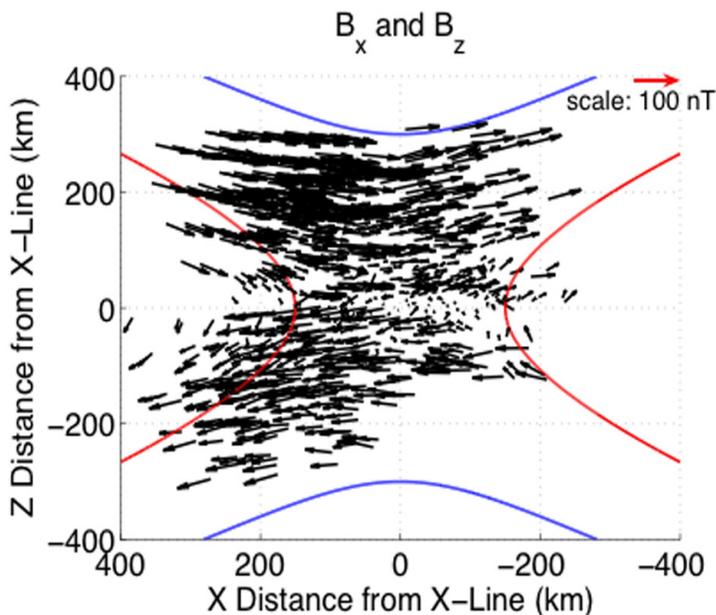
The IMAGE satellite electron density versus L-shell distribution: This new database has recently been finished by Yongli Wang and his team with automatic and manual techniques and more than 200,000 data points spanning five years.

Deirdre Wendel



Dr Deirdre Wendel is a magnetospheric plasma physicist who joined the Geospace Physics Laboratory, Code 673, in September 2009. She specializes in studying in situ magnetic reconnection from the vantage point of a multiple-spacecraft observatory. She received her BS in physics from Columbia University and her MSc in physics from the University of California and from Rice University. She worked as a scientist and engineer in industry for five years, and, in 2009, she completed her PhD in physics from Rice University.

In 2010, Dr Wendel served on the Science Director's Council for the Science and Exploration Directorate at GSFC. She also chaired the 2010 Peer Awards Committee for the HSD. In April 2010, she undertook the weeklong GSFC-sponsored Technical Management Training workshop.



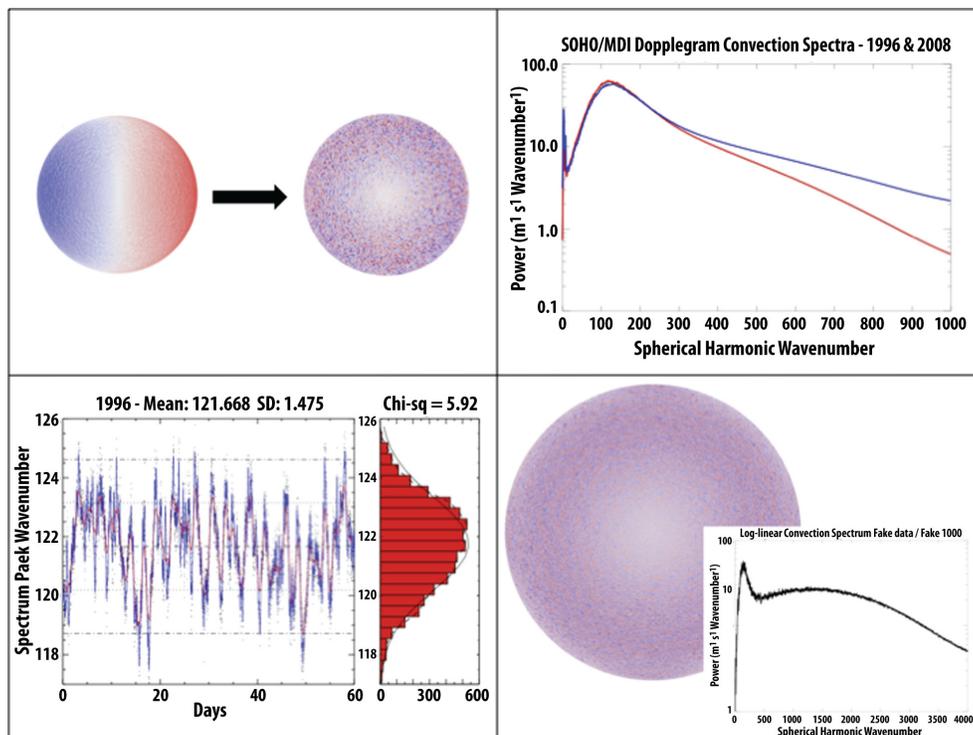
The arrows represent the magnetic field measured by the four Cluster spacecraft after being positioned in the instantaneous coordinate system centered on the x-line. The motion of the x-line has been removed.

Dr Wendel pursues research to unravel the spatial and temporal characteristics of magnetic reconnection in the near-Earth space environment. In 2009, she published a method using multiple spacecraft magnetic field measurements to establish the instantaneous rest frame of the magnetic reconnection site (see figure). Currently, she is applying this method to a k-filtering analysis of turbulent reconnection in order to derive the spectral characteristics and the effective electric field associated with turbulent magnetic reconnection in space. This year she has also pursued and presented an analysis explaining the 3D magnetic topology observed by the Cluster spacecraft wherein antiparallel reconnection produces a guide field within the magnetopause. To assist the Science Working Group for the Magnetospheric Multi-Scale Mission (MMS), she is also vetting multiple spacecraft techniques on virtual spacecraft flying through simulated reconnection data.

Peter Williams



Dr Peter Williams is a third-year NPP and continues his work with Dean Pesnell analyzing Doppler velocity images from the SOHO/MDI. These images can be reduced to extract surface manifestations of internal convection mechanisms, seen as either granule or supergranule cells. Supergranules are significant in such studies as there is clear evidence of magnetic field interactions within, and at the boundaries of, such cells. The past year has involved studying various characteristics of these features and comparing our results between the past two minima, using MDI data from 1996 and 2008. Although the supergranule lifetimes tend to be similar for both years, we find that supergranules are smaller and their flows stronger in 2008 than in 1996. We are statistically analyzing the data to study its noise characteristics to provide a firmer base for interyear comparisons. We are continuing preparations for processing Doppler data from HMI for high-resolution convection analyses.



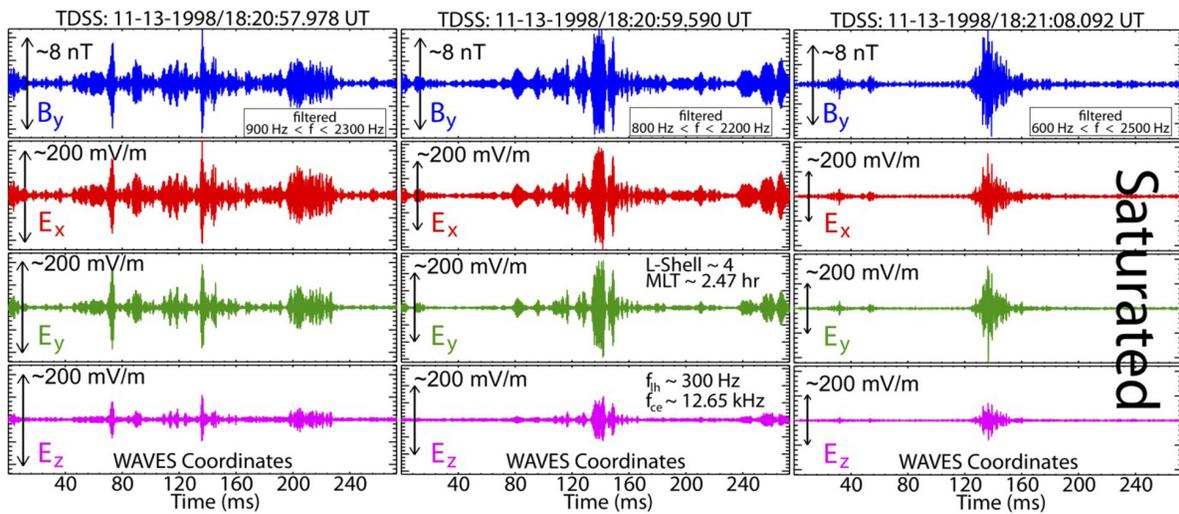
Doppler velocity images (upper left), that illustrate surface flows toward (blue) and away (red) from the observer, are reduced to display only those flows due to surface convection features. Spectra of convection cell sizes can be derived (upper right), showing a peak corresponding to supergranulation, from which a global average of supergranule size may be estimated. The results show sizes of ~35 Mm. Plotting a time-series of supergranule sizes derived from individual spectra shows quasi-oscillatory behavior (lower left). Stochastic processes within solar convection may be changing the global supergranule size over time. A simulated HMI convection image, with its spectrum showing both supergranule and granule peaks (lower right), offers expected results of future HMI Doppler image analyses.

Lynn B. Wilson III



Dr Lynn B. Wilson, III was born in Grand Rapids, MN. Lynn obtained his Bachelor of Arts degree in physics from Saint John’s University, Collegeville, MN, in May 2005, and his PhD from the University of Minnesota in September 2010. His dissertation focused on the microphysics of interplanetary (IP) shocks using data from the WIND spacecraft. Lynn developed documented portable software libraries for the WAVES TDS and 3DP instruments. He began working at GSFC in September 2010.

In 2010, Lynn has worked primarily on WIND spacecraft observations leading to seven publications submitted, in press, or already published. He is currently working on finishing a paper on the first characterization of electron distributions observed simultaneously with large-amplitude (>200-mV/m) whistler waves in the terrestrial radiation belts. Lynn is also starting another paper on characteristics of particle distributions associated with lower hybrid waves observed in the ramp regions of IP shocks. He just returned from a trip to Berkeley, CA, where he presented a physics colloquium on work recently accepted in the Journal of Geophysical Research. Lynn will be presenting his work on whistler waves at the 2010 Fall AGU meeting.



Three TDSS large amplitude whistler events.

Charles L. Wolff

Dr Charles L. Wolff is an Emeritus member of the Solar Physics Branch. His research aims to explain why the Sun's solar activity, luminous output, and neutrino flux all vary on numerous time scales. He has found some answers deep inside the Sun and, this year, found one answer outside the Sun. He received his PhD from the University of Illinois in physics with a minor in astronomy. His BS degree was from the Pennsylvania State University. He has been at GSFC for many decades and, in recent years, served on several NSF proposal review panels.

This year Dr Wolff published the first physical mechanism involving planets that is shown to have enough energy to cause a meaningful change on the Sun. It is a new way, not involving tides, whereby the planetary system can trigger energetic transient events in the Sun. Less suddenly, it can increase solar activity levels in general. The mechanism is a fluid instability that pumps energy into an existing solar convection cell if it is in an ideal location and phase of development.

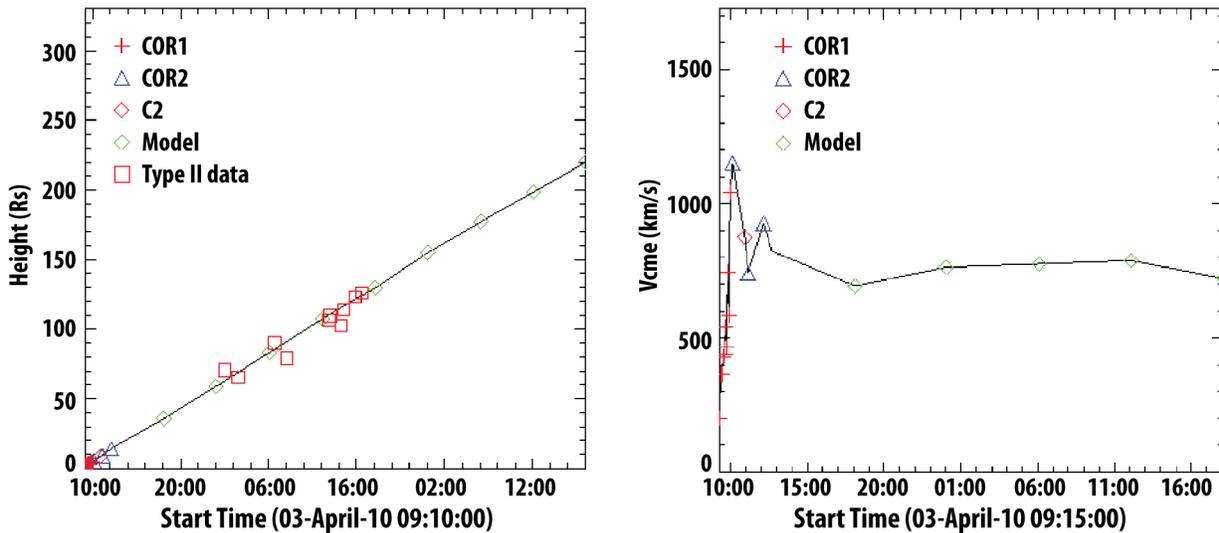
The potential energy for the instability is available on the solar hemisphere that is facing the barycenter of the solar system, i.e., its inertially stationary point. However, energy is released primarily in well-mixed layers where buoyancy does not inhibit vertical motion. In the convective envelope, stronger events originate in deeper layers where the natural response times are several weeks. This delays their effect on the surface by similar lengths of time. Due to solar rotation, these stronger events will be seen at larger longitudes relative to the barycenter direction. These predictions are now being tested against observations of the very energetic Moreton waves.

This planetary effect on solar time behavior supplements previous work by Wolff on how solar activity is modulated by rigidly rotating, oscillating structures based on groups of g modes. The g modes of that model are driven by nuclear burning in small parts of the solar core, which nonlinearly couples each group of modes into one structure. Since the burning varies with time and this changes the neutrino generation rate, it would explain heretofore-puzzling reports that solar activity levels correlate somewhat with changes in neutrino flux.

Hong Xie



Dr Hong Xie, a solar physicist with CUA, joined Code 671 in April 2003. She has been working on data analysis of coronal mass ejections (CMEs), CME-driven shocks, and associated geomagnetic storms. She is currently maintaining the COR1 preliminary CME catalog. Her research interests include the origin, three-dimensional structure, and evolution of CMEs and shocks. She has developed new analytical CME cone model fitting procedure, and incorporated a geometrical flux-rope model fitting for STEREO/COR coronagraph images.



Kinematic evolution of the 2010 April03 CME. Left: the height-time profiles combining the flux-rope fitting results to STEREO COR1/2, LASCO C2/C3 images and simulation results from CCMC ENLIL⁺ cone model. Right: derived CME space speed, which increases from ~200 km/s (09:00 UT) to ~1149 km/s (10:00 UT) before falling to 750 km/s.

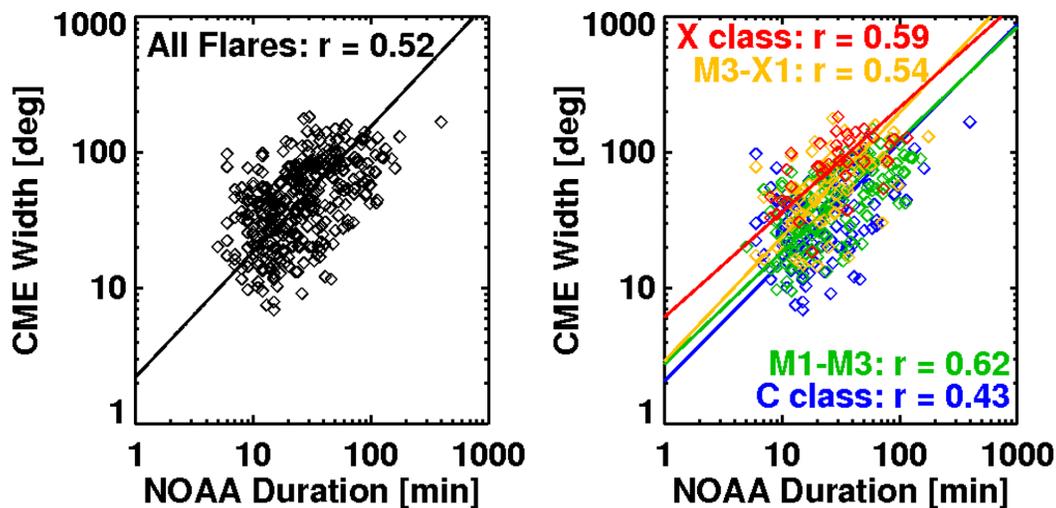
In 2010, working with Dr Gopalswamy, Dr St. Cyr, and the STEREO team, Dr Xie studied and analyzed the properties of CMEs, eruptive prominences, flares, and Type II radio emissions that associated with interplanetary (IP) shocks and contributed the CME flux-rope fitting results to CDAW 2010. By using flux-rope models and 3D triangulations, she has studied the origin, propagation direction, and kinematic evolution of CMEs, and has improved the shock prediction based on the empirical shock arrival (ESA) model and the kilometric Type II radio technique by synthesizing CME acceleration and the shock speed from kilometric Type II bursts. In addition, she used CCMC ENLIL⁺ cone model and J-maps from STEREO COR-2/HI-1/HI-2 to understand IP shock dynamics and predict shock location and strength in the inner heliosphere. She compared the simulation results with observed height-time profiles as well as in situ data (WIND, ACE, and STEREO A/B).

Seiji Yashiro



Dr Seiji Yashiro was born in Sagami-hara, Kanagawa, Japan. Seiji received his Bachelor in Science degree from Tokyo University of Science in 1995, and his PhD from The University of Tokyo in 2000. His dissertation work is on the investigation of the evolution of coronal active regions by using Yohkoh data. After defending his thesis, he started working at GSFC as a contractor of The Catholic University of America. He helps maintain the CDAW Data Center (<http://cdaw.gsfc.nasa.gov>) that consists of the SOHO/LASCO CME Catalog and other CME-related data.

In 2010, Seiji developed side-by-side JavaScript movies that are helpful in investigating to the connections between two different images taken by STEREO EUVI, COR1, COR2, and SWAVES. The movies have been served at the CDAW Data Center.



Scatter plots between flare duration and CME width.

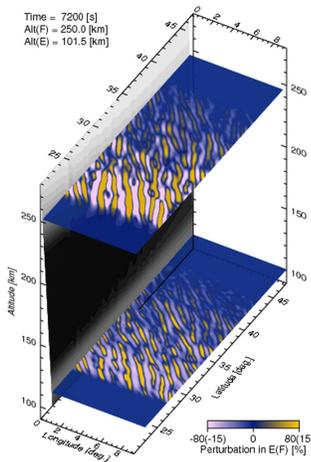
Seiji continues analyzing the relationship between solar flares and CMEs in collaboration with Dr Gopalswamy at Code 671. They performed a statistical study assessing how the soft X-ray flare durations affect the flare-CME relationship and found a clear correlation between the flare duration and CME width. They also found that the decay is exponential for all flares (with and without CMEs). On the average, flares associated with wider CMEs take longer to decay. The results were presented in the SHINE meeting in Santa Fe, NM. Seiji was invited to the WCU (World Class University) International workshop held by Kyung Hee University in South Korea to present a talk entitled “Coronal Mass Ejections and Space Weather.”

Tatsuhiro Yokoyama



Dr Tatsuhiro Yokoyama obtained his PhD from Kyoto University, Japan in 2004. He worked on radar/rocket observations and numerical modeling of ionospheric irregularities associated with sporadic-E layers in midlatitude. He collaborated with Dr Pfaff on a DC electric field instrument during the Japanese rocket campaign in 2002, which was his first experience in working with GSFC. After a few years of postdoctoral positions at Kyoto University and Nagoya University, Dr Yokoyama studied at Cornell University as a JSPS postdoctoral fellow from November 2006 to March 2010. He has expanded his research target from the ionospheric E to F region and from midlatitude to the equatorial region during his postdoctoral career. He joined GSFC in April 2010 as a Visiting Assistant Research Scientist at UMBC/GEST.

Dr Yokoyama developed his own numerical model of the midlatitude ionosphere aiming at electrodynamical coupling between the ionospheric E and F regions. His model successfully reproduced plasma density structures aligned northwest to southeast that are frequently observed in the midlatitude ionosphere both in the E and F regions. The important finding is that the neutral wind in the E region controls the electrodynamics in the F region through the coupling process.



LEFT: Numerical results on northwest-southeast density perturbations by E-F coupled model. RIGHT: View of the Equatorial Atmosphere Radar (EAR)

He has started to use C/NOFS satellite data to compare them with ground-based instruments such as the Equatorial Atmosphere Radar (EAR) in Indonesia (100.32°E, 0.2°S; dip latitude 10.36°S). Deep plasma density depletions, or plasma bubbles, cause severe scintillation on communication/navigation systems. Utilizing the rapid beam-steering capability of the EAR, spatial-temporal structures of the plasma bubbles can be understood, which could make it possible to forecast the scintillation.

C. Alex Young



Dr C. Alex Young, ADNET Systems Inc., works to develop signal- and image-processing methods and software to facilitate a more complete extraction of scientific information from solar physics data. This is both to aid both the community as a whole and his own research into the prediction and understanding of dynamic phenomena in the solar corona such as solar flares and coronal mass ejections. Dr Young enjoys public speaking and sharing information about the Sun and Space Weather with the public. In addition to continuing as a requested interviewee for NASA's GSFC, TV liveshots and television news, he presented a day of lectures to science teachers attending a solar science workshop at the McAuliffe-Shephard Discovery Center.

He also began the development of communities around the sharing of general solar knowledge with the public and solar image processing knowledge with the solar community. For the public he first started a Facebook Page, www.facebook.com/thesuntoday. Subsequently, he developed the The Sun Today community at a separate Web site, www.thesuntoday.org, which is connected to the FaceBook page, a YouTube channel, and a Twitter feed.

For the solar physics data analysis community, Dr Young started a Web site in conjunction with the 5th Solar Image Processing workshop that he helped to organize and run during September 2010 in Switzerland. He also edited another Special Topic Volume of Solar Physics on Solar Image Processing, which was inspired by the 4th Solar Image Processing Workshop in Baltimore, MD, during October 2008.



<http://www.thesuntoday.org>



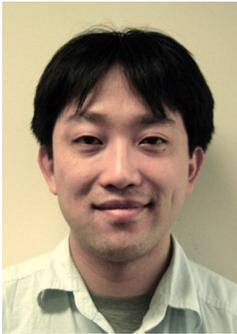
<http://www.sipwork.org>

Dominic Zarro



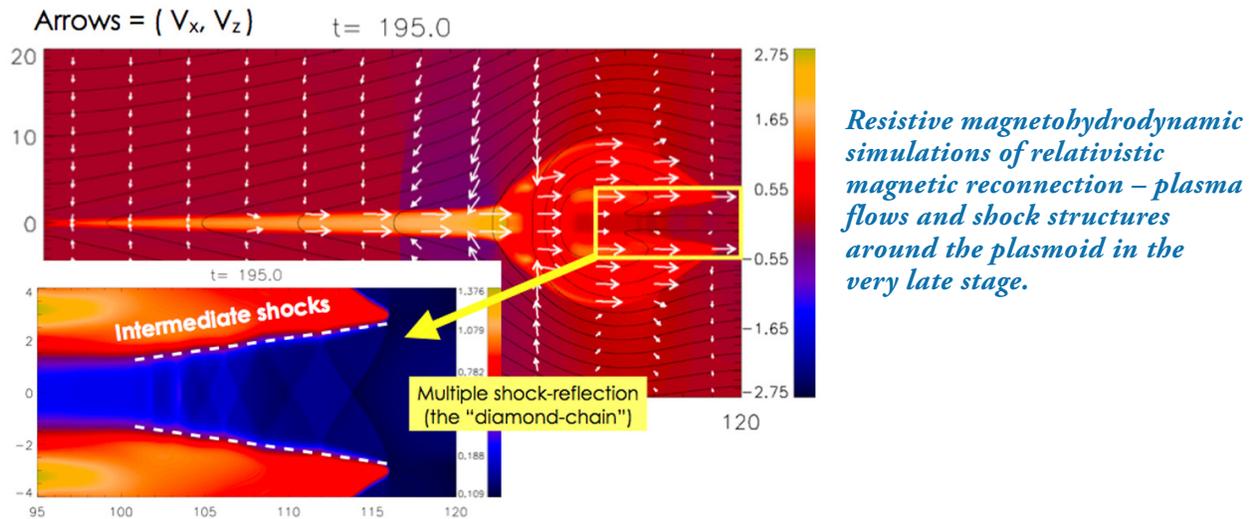
Dr Dominic Zarro graduated with a PhD in astronomy from the Australian National University, Mt. Stromlo Observatory. Dominic served a two-year Postdoctoral Fellowship at the California Institute of Technology, Big Bear Solar Observatory, before joining NASA's GSFC in 1985. He has supported a variety of solar spacecraft missions (SMM, Yohkoh, SOHO, TRACE, RHESSI, and Hinode), and has been involved in research projects to study the physics of flare heating and chromospheric evaporation. He has made numerous contributions to the Solar Software (SSW) library, including useful tools to display and overlay images from different space- and ground-based observatories. He is currently involved in developing interfaces to the Virtual Solar Observatory (VSO) to enhance its data analysis capability.

Seiji Zenitani



Dr Zenitani joined Code 674 in November 2006, after completing his PhD work in space physics at the University of Tokyo. His dissertation work is on particle acceleration processes and kinetic instabilities of the current sheet structure in relativistic electron-positron pair plasmas in astrophysical settings. He is currently a visiting researcher at UMBC from the Japan Society for the Promotion of Science (JSPS), a Japanese NSF-like agency. At GSFC, he has been collaborating with Dr Michael Hesse, Dr Alex Klimas, and Dr Masha Kuznetsova on numerical modeling of magnetic reconnection.

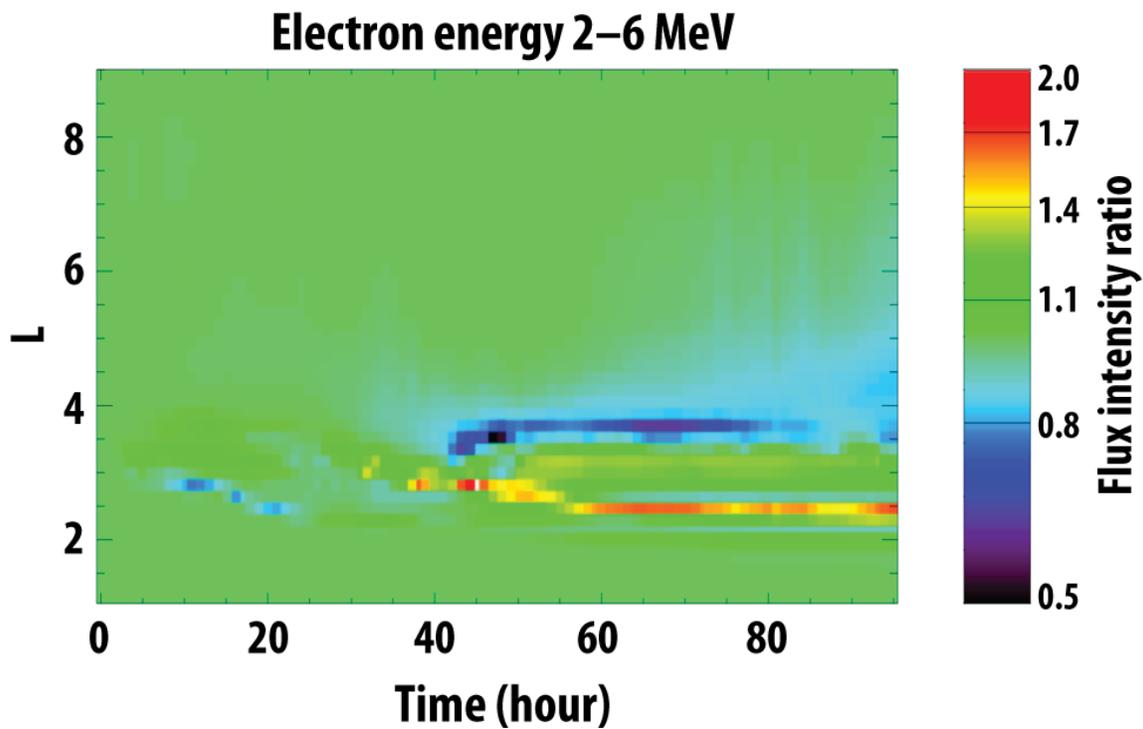
Recently he has been working on fluid and magnetofluid modeling of relativistic magnetic reconnection in order to bridge macroscopic MHD theories and microscopic kinetic results. In 2010, he carried out resistive relativistic magnetohydrodynamic (RRMHD) simulations of magnetic reconnection, and demonstrated a variety of fine plasmoid structures. These results may have important implications for nonrelativistic plasmoid structures. He also worked on velocity-shear problems of relativistic jets as a by-product of his investigations. Currently he is working on kinetic modeling of collisionless magnetic reconnection in the context of the Earth's magnetopause, by means of particle-in-cell (PIC) simulations.



Qiuhua Zheng



Dr Qiuhua Zheng is with NASA/UMCP CRESST, and has been working at GSFC's Code 673 since January 2009. He received his PhD in physics from the University of New Hampshire in 2004. He then worked on lidar simulations and molecular scattering modeling as a research scientist at Michigan Aerospace Corporation after graduation. His current research is focusing on the modeling/simulation of Earth radiation belt particle dynamics. Recently he finished calculating diffusion rates due to three major waves in the magnetosphere: the whistler mode chorus wave, the electromagnetic ion cyclotron wave, and the plasmaspheric hiss. The calculated diffusion coefficients are then taken as input by the radiation belt model and the ring current model.



Effect of cross diffusion. Ratios between simulated radiation belt electron fluxes with and without pitch angle and energy cross diffusion. This plot shows that cross diffusion tends to reduce flux intensities in the outer belt.

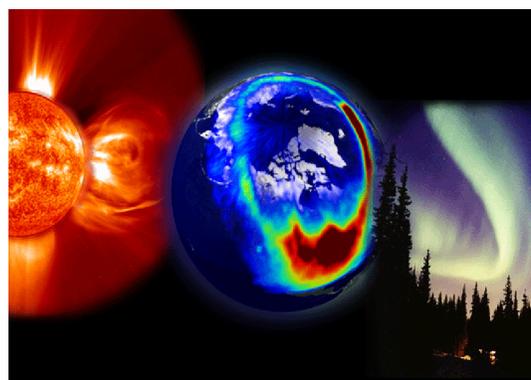
Yihua Zheng



Dr Yihua Zheng joined the Space Weather Laboratory as a research astrophysicist in February 2010. After finishing her PhD in physics from the University of New Hampshire in 2001, she came to GSFC as a postdoctoral fellow and worked with Drs Mei-Ching Fok, Tom Moore, Guan Le, Jim Slavin and others. In 2005, she took a position at APL and worked there as a scientist before returning to GSFC in 2010.

Dr Zheng's research experience includes ring current/radiation belt modeling, subauroral electric fields, space weather physics and modeling, ULF waves in the tail, ionospheric outflow, dayside magnetopause reconnection, field-aligned currents in the auroral zone, and multipoint data analysis of the broad magnetosphere and ionosphere system. During her graduate studies (1997–2001), Dr Zheng was involved in scientific development and design of the deploying system for four autonomous magnetometers onboard a sounding rocket called Enstrophy, and was in charge of the data reduction process of the magnetometers. Her postdoctoral work has focused on turning the radiation belt model into an operational product for the UPOS projects, as well as on the Comprehensive Ring Current and Radiation Belt Environment models and their application to scientific questions related to the coupled inner magnetosphere and ionosphere system. Dr Zheng has served as PI on one NASA-Geospace grant and one NSF grant, and as Co-Investigator on four other NASA/NSF grants. She has been a lead session convener for the Fall 2007 and 2009 AGU meetings and guest editor for a JASTP special issue. She served on one NASA and one NSF proposal selection panel in 2010.

Dr Zheng is now involved in providing and improving space weather services to NASA robotic missions, including planetary missions. One of her current interests is to expand her research domain by analyzing space weather events from a broader perspective, starting from the originator: the Sun, to understand the full chain of physical processes involved in initiation and propagation of Space Weather events and their effects throughout the interplanetary space, combining modeling results and observations.



Dr Zheng is interested in initiation and propagation of Space Weather events and their effects throughout interplanetary space.

APPENDIX B: Publications & Presentations

In FY2010, HSD has published a total of 201 papers in a wide variety of scientific journals and workshop proceedings, including four papers in Science. Nearly half of the papers (45%) have had HSD scientists as first authors. (The HSD members have last names in bold face.) A further 57 HSD authored and coauthored articles have been submitted, accepted, gone to press, or been published since the end of the fiscal year. An extensive list of these papers is given in the next two sections of this appendix.

The HSD members gave a total of 406 presentations (talks and posters) at a total of 75 different science meetings spread all across the US and around the World; about 70 of the presentations were invited talks. The bulk of the HSD presentations were given at the AGU Fall, AGU/SPD Spring, EGU, and Space Weather Workshop meetings. HSD members helped organize workshops and special sessions at a number of these meetings.

These figures apply to papers published between 1 October 2009 and 30 September 2010 but probably underestimate the body of work published and presented by the HSD group at GSFC. These figures cannot be compared directly to the 2008 and 2009 Annual Reports as this list has been strictly based on FY2010 while in the previous two years' reports, many of the papers were grouped by calendar year and the various publication dates can fall in different fiscal years.

1st Author Papers

1. Benson, R.F., “Four decades of space-borne radio sounding,” *Radio Science Bull.*, No. 333, pp. 24-44, 2010 Jun
2. **Bhatia**, A.K., “Elastic scattering and photon absorption in two-electron systems,” paper given at *Second International Conf. on Current Developments in Atomic, Molecular, and Optical Physics with Applications (CDAMOP)*, 2006 Mar 21-23, Delhi, India; published in *Atomic Structure and Collision Processes*, ed. M. Mohan (Narosa Publishing House), pp. 87-103, 2010 Jun-Jul; ISBN 978-81-7319-811-3
3. **Boardsen**, S.A., T. Sundberg, J.A. **Slavin**, B.J. Anderson, H. Korth, S.C. Solomon, and L.G. Blomberg, “Observations of Kelvin-Helmholtz waves along the dusk-side boundary of Mercury’s magnetosphere during MESSENGER’s third flyby,” *Geophys. Res. Lett.*, **37**, L12101, 5 pp., 2010 Jun; doi: 10.1029/2010GL043606
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5. **Burlaga**, L.F., N.F. Ness, Y.M. Wang, N.R. Sheeley, and J.D. Richardson, “Observations of the magnetic field and plasma in the heliosheath by Voyager 2 from 2007.7 to 2009.4,” *J. Geophys. Res.*, **115**, A08107, 8 pp., 2010 Aug; doi: 10.1029/2009JA015239
6. **Buzulukova**, N., M.-C. H. **Fok**, A. **Pulkkinen**, M. **Kuznetsova**, T.E. **Moore**, A. **Glocer**, P.C. Brandt, G. Tóth, and L. **Rastaetter**, “Dynamics of ring current and electric fields in the inner magnetosphere during disturbed periods: CRCM-BATS-R-US coupled model,” *J. Geophys. Res.*, **115**, A05210, 19 pp., 2010 May; doi: 10.1029/2009JA014621
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9. **Duvall**, T.L., and S.M. Hanasoge, “Measuring Meridional Circulation in the Sun,” *Solar-Stellar Dynamos as Revealed by Helio and Astroseismology: GONG 2008/SOHO 21*, held at the High Altitude Observatory, Boulder, Colorado, 2008 Aug 11-15; published in *ASP Conf. Ser.* **416**, 103-109, 2009 Dec; eds. M. Dikpati et al. (San Francisco: Astron. Soc. Pacific); ISBN: 978-58381-712-4
10. **Feofilov**, A.G., and S.V. Petelina, “Relation between mesospheric ice clouds, temperature, and water vapor determined from Odin/OSIRIS and TIMED/SABER data,” *J. Geophys. Res.*, **115**, D18305, 12 pp., 2010 Sep; doi: 10.1029/2009JD013619
11. **Feofilov**, A.G., A.A. **Kutepov**, W.D. **Pesnell**, R.A. **Goldberg**, B.T. Marshall, L.L. Gordley, M. Garcia-Comas, M. Lopez-Puertas, R.O. Manuilova, V.A. Yankovsky, S.V. Petelina, and J.M. Russell, “Daytime SABER/TIMED observations of water vapor in the mesosphere: retrieval approach and first results,” *Atmos. Chem. Phys.*, **9**(21), 8139-8158, 2009 Nov; doi: 10.5194/acp-9-8139-2009 (<http://www.atmos-chem-phys.net/9/8139/2009/acp-9-8139-2009.html>)

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12. **Antiochos**, S.K., *Helicity in CMEs/Flares: Nothing but Spin*, INVITED presentation at the workshop on The Origin, Evolution, and Diagnosis of Solar Flare Magnetic Fields and Plasmas, 08/10, Boulder, CO
13. **Antiochos**, S.K., *The Dynamic Connection Between the Sun and Heliosphere*, University of Maryland, Space Science Seminar, 09/10, College Park, MD
14. **Barbier**, S.B., L.M. Bartolone, E.R. **Christian**, T.E. Eastman, E.M. **Lewis**, and J.R. Thieman, *Extraordinary Matter: Visualizing Space Plasmas and Particles*, poster presented at **Astronomical Society of the Pacific** Annual Meeting, Boulder, Colorado, July/August 2010
15. **Barbier**, S.B., L.M. Bartolone, E.R. **Christian**, T.E. Eastman, E.M. **Lewis**, and J.R. Thieman, *Visualizing Space Plasmas and Particles for Education: Extraordinary Matter*, poster presented at **International Society for Technology in Education** Conference, Denver, Colorado, June 2010
16. **Barbier**, S.B., L.M. Bartolone, E.R. **Christian**, T.E. Eastman, E.M. **Lewis**, and J.R. Thieman, J.R., *Extraordinary Matter: Visualizing Space Plasmas and Particles*, poster presented at **American Geophysical Union** Fall Meeting, San Francisco, California, December 2009

17. **Benson**, R.F., *South pole experience & science educational & public outreach*, INVITED presentation at the Interactive NASA Space Physics Ionosphere Radio Experiments (INSPIRE) workshop 2009-2010 Teaching Science with an Enthusiastic Attitude held on 2 October 2009 at Gallaudet University, Washington, D.C.
18. **Benson**, R.F., D. **Bilitza**, J. M. Grebowsky, V. Truhlik, Y. **Wang**, and B.W. Reinisch, *High-Altitude High-Latitude Electron-Density and Magnetic-Field Enhancements Observed during Magnetic Storms – Including the Storm of 17 April 2002*, poster SM13C-1613 presented at the fall 2009 AGU meeting held from 14-18 December 2009 in San Francisco, California.
19. Bentley, R.D., J. Abouadarham, A. Csillaghy, C. Jacquy, M.A. Hapgood, M. Messerotti, P. Gallagher, K. Bocchialini, N. E. Hurlburt, D.A. **Roberts**, and L. Sanchez Duarte, *Addressing Science Use Cases with HELIO*
20. **Bilitza**, D., *IRI – Recent Activities and Connections to EURIPOS*, INVITED talk presented at **EGU meeting**, Vienna, Austria, May 2010.
21. **Bilitza**, D., R. **Benson**, B. Reinisch, and X Huang, *Alouette and ISIS Topside Sounder Measurements – A Data Source for Improvements of the IRI Model in the Topside Ionosphere*, poster presented at the **COSPAR meeting**, Bremen, Germany, July 2010.
22. **Bilitza**, D., R F **Benson**, B W Reinisch, X Huang, *The ISIS Story - Science Return from Rescuing, Archiving and Analyzing a Unique Dataset*, poster presented at **AGU Fall meeting**, San Francisco, December 2009
23. **Bilitza** D. and B. Reinisch, *International Reference Ionosphere - 2010*, INVITED talk presented at the **COSPAR meeting**, Bremen, Germany, July 2010.
24. **Bilitza**, D., B. Reinisch, and T. Gulyaeva, *ISO Technical Specification for the Ionosphere – IRI Recent Activities*, INVITED talk presented at the **COSPAR meeting**, Bremen, Germany, July 2010.
25. **Bilitza**, D., V. Truhlik, P.G. Richards, and L. Triskova, *An effect of the 27 days solar rotation period on the electron density in the upper and topside ionosphere*, INVITED talk presented at the **IRI Workshop**, Kagoshima, Japan, November 2009.
26. **Bilitza**, D., V. Truhlik, and L.Triskova, *Relative Importance of the Quasi 27-day solar rotation period on foF2 and foE*, poster presented at **EGU meeting**, Vienna, Austria, May 2010.
27. **Boardsen** S.A. and J.A. **Slavin**, *Kelvin-Helmholtz Analysis of Magnetopause Oscillations*, 19th MESSENGER Science Team Meeting, Columbia, Md., Nov. 2009.
28. **Boardsen**, S.A., J. A. **Slavin**, B.J. Anderson, H. Korth and S.C. Solomon, *Ultra-Low-Frequency Wave Observations at Mercury during the 29 September 2009 MESSENGER Flyby*, Eos Trans. AGU, 90(52), Fall Meet. Suppl., Abstract P21A-1205, Dec. 2009.
29. **Boardsen**, S.A., T. Sundberg, J.A. **Slavin**, B.J. Anderson, H. Korth, S.C. Solomon, and L.G. Blomberg, *Observations of Kelvin-Helmholtz Waves during the Third MESSENGER flyby of Mercury*, EGU2010-5198, May 2010.
30. **Boardsen**, S.A., T. Sundberg, J.A. **Slavin**, B.J. Anderson, H. Korth, S. C. Solomon, and L. G. Blomberg, *Observations of Kelvin-Helmholtz Waves during the Third MESSENGER flyby of Mercury*, 20th MESSENGER Science Team Meeting, Boston, Mass., June 2010.
31. Boller, R.A., V. Kalk, D.A. **Roberts**, R. Kesel, D. Berios, and M.M. **Maddox**, *Three-dimensional Integration, Analysis, and Visualization of Simulated and Observed Heliophysics Data*

32. Breech, B. A., M.L. **Goldstein**, A.V. **Usmanov**, and D.A. **Roberts**, *A Simplified Transport Model for sub-Alfvénic Flows in the Corona*
33. **Brosius**, J.W., and G.D. **Holman**, *Fast Cold Upflows during a Solar Microflare Observed with RHESSI and SOHO's CDS*, B.A.A.S., 42, 902, 2010.
34. **Brosius**, J.W., *Chromospheric Evaporation During a Solar Microflare Using RHESSI and SOHO/CDS*, talk given at the 10th RHESSI Workshop, held in Annapolis, MD, 2010 August 1-6
35. **Burlaga**. L. F., N. F. Ness, J. D., Richardson, Y.-M. Wang., and N. R Sheeley Jr., *Observations of the Magnetic Field and Plasma in the Heliosheath by Voyager 2*, contributed talk presented at **Joint Voyager-IBEX meeting**, San Antonio, TX, March, 2010
36. **Buzulukova**, N., M.-C. H. **Fok**, P.W. Valek, J. Goldstein, D.J. McComas, and P.C. Brandt, *Ring current behavior in weak and strong storm: What controls a storm size?*, contributed talk at **Fall AGU meeting**, San Francisco, December 2009
37. **Candey**, R.M., D. **Bilitza**, R. Chimiak, J. F. **Cooper**, L.N. Garcia, B. Harris, R.C. Johnson, J. H. **King**, T. **Kovalick**, H. **Leckner**, M. **Liu**, R.E. **McGuire**, N.E. **Papitashvili**, and D.A. **Roberts**, *Putting Space Physics Data Facility (SPDF) services to good use*, contributed poster SH51B-1282 presented at **Fall 2009 AGU Meeting**, San Francisco, Ca, Dec. 14-18, 2009
38. **Chamberlin**, P.C., and the SDO EVE Team, *Comparisons of the Flare Irradiance Spectral Model (FISM) to preliminary SDO EVE data*, COSPAR General Assembly, July 2010, Bremen, Germany.
39. **Chamberlin**, P.C., and the SDO EVE Team, *Ultraviolet Observations of Solar Variability from the Solar Dynamics Observatory*, AAS/SPD Meeting, May 2010, Miami, Florida.
40. **Chamberlin**, P.C., *The Solar Dynamics Observatory, Our New Eye on the Sun*, Boston University, Center for Space Physics Seminar, April 1, 2010, Boston, Massachusetts, USA. **INVITED**
41. **Chamberlin**, P.C., *The Solar Dynamics Observatory, studying the Sun and its influence on other bodies in the solar system*, University of Central Florida, Planetary Sciences Group, February 5, 2010, Orlando, Florida, USA. **INVITED**.
42. **Chamberlin**, P.C., T. N. Woods, and L. Qian, *A comparison of solar EUV irradiance reference spectra and their affect on the Earth's Thermosphere and Ionosphere*, American Geophysics Union, Fall Meeting, San Francisco, CA, Dec 2009.
43. **Chen**, P.C., M.E. Van Steenberg, D.M. **Rabin**, and R.J. Oliverson, *A Scalable Superconductor Bearing System for Lunar Telescopes and Instruments*, poster presented at **3rd Lunar Science Forum**, NASA Ames, Moffett Field, California, July 2010
44. **Chen**, P.C., M.E. Van Steenberg, and D.M. **Rabin**, *Moon Dust, Telescopes, Solar Concentrators, and Structures or, Fun With Lunar Regolith Simulants*, poster presented at **3rd Lunar Science Forum**, NASA Ames, Moffett Field, California, July 2010
45. **Chen**, P.C. and Y.C. Zheng, *From the Moon to Mars and Beyond*. poster presented at **3rd Lunar Science Forum**, NASA Ames, Moffett Field, California, July 2010
46. **Chen**, P.C., P.D. Lowman, and D.M. **Rabin**, *High Temperature Superconductor Systems for Lunar Telescopes, Instruments, Transportation, and Space Exploration*, poster presented at **Robotic Science from the Moon**, Boulder, Colorado October 2010
47. **Christe**, S., *Automated Microflare Detection*, SIPWorks 5 Meeting, Les Diablerets, Switzerland, 2010
48. **Christe**, S., L. Glesener, S. Krucker, B. Ramsey, S. Ishikawa, T. Takahashi, H. Tajima, *The Focusing Optics Solar Imager (FOXSI)*, AAS/SPD 2010, Miami, Florida, 2010

49. **Christe**, S., L. Glesener, S. Krucker, B. Ramsey, S. Ishikawa, T. Takahashi, H. Tajima, *The Focusing Optics Solar Imager (FOXSI)*, Fall AGU 2009, San Francisco, California
50. **Christian**, E.R., T.T. von Rosenvinge, C.M. Cohen, A.C. Cummings, M. Desai, R.A. Leske, G.M. Mason, R.A. Mewaldt, E.C. Stone, and M.E. Wiedenbeck, *Testing the Origin of Hybrid Solar Energetic Particle Events*, contributed talk presented at **AGU Fall Meeting**, San Francisco, California, December 2009
51. **Christian**, E.R., *The Interstellar Boundary Explorer (IBEX) and Observations of the Heliosheath*, INVITED talk at **Meeting of the Americas**, Foz do Iguassu, Brazil, August 2010
52. **Collado-Vega**, Y., *Magnetopause boundary region vortices observed during dynamic and fixed solar wind conditions: a comparison*, SED Director's Seminar, Goddard Space Flight Center, February 2010
53. **Collado-Vega**, Y., R. Kessel, R. Boller, V. Kalb, *Statistical Study of Magnetopause Boundary Vortices Observed During Modeled Solar Wind Conditions*, poster at GEM Meeting, Snowmass, Colorado, June 2010
54. **Cooper**, J. F., *The new heliosphere meets the new solar system*, contributed talk presented at **ERG, Scope, and Beyond**, ISAS/JAXA, Sagimura, Japan, Nov. 2-5, 2009.
55. **Cooper**, J. F., *Origins of cryovolcanism on icy moons of the giant planet magnetospheres*, contributed talk presented at **CPS Workshop on Icy Moons and Origin of Jupiter and Other Giant Planets**, Hokkaido University, Sapporo, Japan, Nov. 9-10, 2009.
56. **Cooper**, J. F., *Layered model for radiation-induced chemical evolution of icy surface composition and dynamics on Kuiper Belt and Oort Cloud bodies*, contributed talk presented (in absentia) at **2010 Western Pacific Geophysics Meeting**, Taipei, Taiwan, June 22-25, 2010.
57. **Cooper**, J. F., *Lunar virtual observatory facility for plasma-surface-atmosphere interactions*, contributed talk presented at **Lunar Dust, Plasma & Atmosphere: The Next Steps**, Boulder, Colorado, Jan. 27-29, 2010.
58. **Cooper**, J. F., R. B. McKibben, T. Armstrong, M. Hill, N. Lal, and A. Szabo, *Virtual Energetic Particle Observatory support for ground-based neutron monitor data products*, INVITED talk PCB1-0019-10 presented at **38th COSPAR Scientific Assembly**, Bremen, Germany, July 18-25, 2010.
59. **Cooper**, J. F., and E.C. Sittler, *Composition measurement objectives and approaches – Europa Jupiter System Mission*, contributed talk presented at **ERG, Scope, and Beyond**, ISAS/JAXA, Sagimura, Japan, Nov. 2-5, 2009.
60. **Cooper**, J. F., R. E. Hartle, E. C. Sittler, M. A. McGrath, C. J. Alexander, J. B. Dalton, D. Pascu, C. Paranicas, C. Hibbitts, M. E. Hill, P. D. Cooper, R. E. Johnson, T. A. Cassidy, T. M. Orlando, L. J. Lanzerotti, N. A. Schwadron, K. D. Retherford, R. I. Kaiser, F. Leblanc, S. J. Sturmer, and R. M. Killen, *Space weathering impact on solar system surfaces and planetary mission science*, contributed poster P43D-1465 presented at **Fall 2009 AGU Meeting**, San Francisco, Ca, Dec. 14-18, 2009.
61. **Cooper**, J.F., J.H. King, N.E. Papitashvili, H.K. Hills, and A.S. Lipatov, *Lunar Surface Origins Exploration (LunaSOX): virtual observatory facility for solar wind plasma interactions with the Moon*, contributed poster 3059 presented at **Annual Meeting of the Lunar Exploration Analysis Group (LEAG 2010)**, Washington, DC, Sept. 14-16, 2010.
62. **Cooper**, J. F., R.E. Hartle, A.S. Lipatov, E.C. Sittler, T.A. Cassidy, and W.-H. Ip, *Space weathering perspectives on Europa amidst the tempest of the Jupiter magnetospheric system*, INVITED talk EPSC2010-564 presented at **European Planetary Science Congress 2010**, Rome, Italy, Sept. 19-24, 2010.

63. Cooper, P. D., J. F. **Cooper**, E. C. **Sittler**, S.J. Sturmer, and A. Rymer, *Old Faithful model for radiolytic gas-driven cryovolcanism at Enceladus*, contributed talk P41D-02 presented at **Fall 2009 AGU Meeting**, San Francisco, Ca, Dec. 14-18, 2009.
64. **Coyner**, A.J and J.M. **Davila** *Observational Constraints of Coronal Non-Thermal Velocities from Statistical Analysis of SERTS 1991-1997 Linewidth Observations* AGU Fall Meeting, San Francisco California December, 2009
65. **Coyner**, A.J and J.M. **Davila** *Determination Of Non-thermal Velocity Distributions From Spatially-averaged EUV Spectra Observed With SERTS And Hinode/EIS*, 216th Meeting of the AAS, Miami, Florida May, 2010
66. Davey, A.R., J.A. **Hourclé**, and F.I. Suárez Solá, *The VSO Interface to SDO Data - On Top and Underneath*, poster SH33B-1505 at the Fall AGU Meeting, San Francisco, California, December 2009.
67. Davey, A.R., A. Amezcua, R. Bogart, J. **Hourclé**, J. Spencer, I. Suárez Solá, and the VSO Team, *SDO Data Distribution and Access with VSO*, poster 402.21 at the AAS/SPD meeting, Miami, Florida, May 2010
68. Davidson, R.L., G.D. Earle, J.H. **Klenzing**, and R.A. Heelis, *A numerical and empirical study of geometry dependent grid effects in planar retarding potential analyzers*, poster presented at **CEDAR**, Colorado, June 2010
69. **Daw**, A., S. R. Habbal, H. Morgan, M. Druckmüller, A. Ding, J. Johnson, V. Rusin, *Eclipse Observations of the Fe XI 789.2 nm Line*, contributed talk presented at **American Astronomical Society Meeting #215**, Washington, DC, January 2010
70. **Daw**, A., *Introduction to Solar Physics*, INVITED presentation to professors and cadets enrolled in the capstone **course on Small Spacecraft Engineering at the U.S. Air Force Academy**, Colorado Springs, CO, September, 2010
71. **Dennis**, B.R., E.P. Kontar, A. **Gopie**, A.K. **Tolbert**, and R.A. **Schwartz**, *Hard X-ray Footpoint Source Sizes*, AAS/SPD Meeting, Miami, FL, 24-26 May 2010
72. **Dorelli**, J.C., *Applications of Magnetic Reconnection: The Magnetosphere*, Solaire Workshop, St. Andrews, Scotland, 2010.
73. **Duvall**, T.L. Jr., *Time-distance helioseismology from HMI*, presented as a contributed talk at the GONG 2010 – SoHO 24 conference in Aix-en-Provence, France, June 2010.
74. Faden, J., R. S. Weigel, J. D. Vandegriff, R. H. Friedel, and **J. Merka** (2009). *Inside Autoplot: An interface for representing science data in software*. Eos Trans. AGU, 90, (52), Fall Meet. Suppl., Abstract IN11C-1063.
75. **Fainberg**, J.,*R.F. **Benson**, V.A. **Osherovich**, V. Truhlik, Y. **Wang**, S.F **Fung**, and D. **Bilitza**, *Investigating Changes in the High-Latitude Topside Ionosphere During Large Magnetic Storms*, poster presented at **AGU Fall meeting**, San Francisco, December 2009
76. **Feofilov**, A.G., R.A. **Goldberg**, A.A. **Kutepov**, and W.D. **Pesnell**, *Conditions for PMC formation in 2002-2008 estimated from TIMED/SABER measurements*, poster presented at **COSPAR** meeting, Bremen, Germany, July 2010.
77. **Feofilov**, A., A. **Kutepov**, C. She, A.K. Smith, W.D. **Pesnell**, and R.A. **Goldberg**, *CO₂ (v₂)-O quenching rate coefficient derived from coincidental Fort Collins lidar and SABER measurements*, Abstract SA53A-1238, poster presented at the Fall 2010 Meeting of the AGU, December 2009.

78. **Figuroa-Viñas, A.**, C. Gurgiolo, **T. Nieves-Chinchilla**, and **M.L. Goldstein**, *Solar Wind Halo Formation by the Scattering of the Strahl Via Direct Cluster/PEACE Observations of the 3D Velocity Distribution Function*, poster presented at the Spring AGU- Meeting, Foz do Iguacu, Brasil, August 2010.
79. **Fok, M.-C.**, N. **Buzulukova**, P. W. Valek, J. Goldstein, and D. J. McComas, *TWINS Observations of the 22 July 2009 Storm*, presented at Fall AGU Meeting, San Francisco, California, December 14-18, 2009.
80. **Fok, M.-C.**, T.E. **Moore**, S.P. Slinker, J.A. Fedder, D.D. Delcourt, and S.-H. **Chen**, *Modeling the Super Storm in November 2003*, presented at Western Pacific Geophysics Meeting, Taipei, Taiwan, June 22-25, 2010.
81. **Fok, M.-C.**, N. **Buzulukova**, S.-H. **Chen**, P. W. Valek, J. Goldstein, and D.J. McComas, *Simulation and TWINS Observations of the 22 July 2009 Storm*, presented at Western Pacific Geophysics Meeting, Taipei, Taiwan, June 22-25, 2010.
82. **Fainberg, J.**, R.F. **Benson**, V. **Osherovich**, V. Truhlik, Y. **Wang**, **S. Fung**, and D. **Bilitza**, *Investigating Changes in the High-Latitude Topside Ionosphere During Large Magnetic Storms*, poster SM13C-1614 presented at the fall 2009 AGU meeting held from 14-18 December 2009 in San Francisco, California.
83. **Fung, S.F.**, X. Shao, L.N. Garcia, I.A. Galkin, and R.F. **Benson**, *Facilitating Heliophysics Research by the Virtual Wave Observatory (VWO) Context Data Search Capability*, poster presented at the fall 2009 AGU meeting held from 14-18 December 2009 in San Francisco, California.
84. **Gilbert, H.R.**, *Solar Surface Phenomena Associated with Coronal Mass Ejections*, INVITED talk, George Mason University, Fairfax, Virginia, May 7, 2010.
85. **Gilbert, H.R.**, H. **Xie**, D. Alexander, and O.C. **St Cyr**, *The Evolution of Prominence Mass and its Relation to CMEs*, poster at **American Geophysical Union Meeting**, San Francisco, California, December, 2009
86. **Goldberg, R.A.**, A.G. **Feofilov**, A.A. **Kutepov**, F. J. Schmidlin, and J.M. Russell III, *Evidence for interhemispheric coupling during the unusual Northern polar summer mesosphere of 2002*, AGU Fall meeting, San Francisco; Dec 2009, abstract #SA33B-06.
87. **Goldstein, M.L.**, and A.V. **Usmanov**, *A global model of the heliosphere that includes turbulent heating of the solar wind*, 9th Annual International Astrophysical Conference: Pickup Ions Throughout the Heliosphere and Beyond, Maui, Hawaii, March 2010
88. **Gopalswamy, N.**, S. **Yashiro**, P. **Mäkelä**, and K. Shibasaki, *The subdued solar cycle 23/24 minimum revealed by microwave butterfly diagram*, contributed talk given on behalf of N. Gopalswamy at **Fall AGU meeting**, San Francisco, California, 2009 Dec.
89. **Gopalswamy, N.**, *The Sun and Earth's space environment*, Keynote Talk given at the 2009 International Conference on Space Science and Communication, 26-27 October 2009, Port Dickson, Negeri Sembilan, Malaysia
90. **Gopalswamy, N.**, H. **Xie**, P. **Mäkelä**, S. **Yashiro**, S. **Akiyama**, I. Usoskin, *Overview of Cycle 23 GLE Events*, INVITED talk presented at the LWS CDAW on Ground level enhancement events, University of Alabama Huntsville, November 16-18, 2009
91. **Gopalswamy, N.**, *The Sun and Earth's Space Environment*, INVITED talk presented at the Solar Wind-Space Environment Interaction (IAGA-2), Cairo, Egypt, December 4 – 8, 2009

92. **Gopalswamy, N., S. Yashiro, P. Mäkelä, K. Shibasaki** *The subdued solar cycle 23/24 minimum revealed by microwave butterfly diagram*, contributed talk presented at the AGU Fall meeting, San Francisco, CA, December, 2009
93. **Gopalswamy, N.**, *The Sun's Life*, popular talk given at the 16th National Space Science Symposium, Rajkot, India, February 24 – 27, 2010
94. **Gopalswamy, N., P. Mäkelä, S. Yashiro, J. M. Davila, R. A. Howard, R. J. MacDowall, and J.-L. Bougeret**, *Coronal conditions ahead of the extended shock of 2009 May 9*, contributed talk given at the STEREO working group meeting, Dublin, Ireland, March 22 – 26, 2010
95. **Gopalswamy, N., S. Yashiro, P. Mäkelä, K. Shibasaki, and D. Hathaway**, *Polar Chromospheric Signatures of the Subdued Cycle 23/24 Solar Minimum*, Poster paper presented at the American Astronomical Society's Solar Physics Division Meeting, Miami, Florida, May 23 – 27, 2010
96. **Gopalswamy, N.**, *Coronal Mass Ejections: a Summary of Recent Results*, INVITED paper presented at the 20th Slovakian Solar Seminar, Podjavornik, Slovakia, May 31 – June 4, 2010
97. **Gopalswamy, N.**, *Evolution of Interplanetary Shocks and their CME Drivers*, INVITED talk presented at the Western Pacific Geophysics Meeting, Taipei, Taiwan, June 22- 25, 2010
98. **Gopalswamy, N.**, *Coronal Mass Ejections as Key Players in Sun-Earth Connection*, Distinguished Lecture of the Solar terrestrial section presented at the Asia Oceania Geosciences Society meeting, Hyderabad, India, July 5 – 9, 2010
99. **Gopalswamy, N.**, *Coronal mass Ejections, Shocks, and Type II Radio Bursts*, INVITED talk presented at the Asia Oceania Geosciences Society meeting, Hyderabad, India, July 5 – 9, 2010
100. **Gopalswamy, N., S. Yashiro, P. Mäkelä, K. Shibasaki, and D. Hathaway**, *The Peculiar Solar Minimum 23/24 Revealed by the Microwave Butterfly Diagram*, contributed paper presented at the Asia Oceania Geosciences Society meeting, Hyderabad, India, July 5 – 9, 2010
101. **Gopalswamy, N., H. Xie, S. Yashiro, P. Mäkelä, S. Akiyama**, *Influences of the Driver and Ambient Medium Characteristics on the Formation of Shocks in the Solar Atmosphere*, poster paper presented at the 12th Solar Terrestrial Physics Symposium, Berlin, Germany, July 12 – 16, 2010
102. **Gopalswamy, N., J.M. Davila, and B J. Thompson**, *The International Space Weather Initiative*, poster paper presented at the 12th Solar Terrestrial Physics Symposium, Berlin, Germany, July 12 – 16, 2010
103. **Gopalswamy, N., P. Mäkelä, H. Xie**, *Type III Radio Burst Duration and SEP events*, poster paper presented at the 2010 SHINE meeting, Santa Fe, July 26 – 30, 2010
104. **Gopalswamy, N., H. Xie, S. Yashiro, S. Akiyama, P. Mäkelä, and Usoskin, I.**, *Solar Source and CME Properties of Solar Cycle 23 Ground Level Enhancement Events*, contributed talk presented at the Meeting of the Americas, Foz do Iguassu, Brazil, August 8 -12, 2010
105. **Gopalswamy, N., H. Xie, S. Yashiro, P. Mäkelä, and S. Akiyama**, *Radio-Loud CMEs with no Shock near Earth*, INVITED talk presented at the LWS Focused Science Team meeting, Boulder, Colorado, August 18 – 19, 2010
106. **Gopalswamy, N. and P. Mäkelä**, *Low-frequency type III radio bursts and solar energetic particle events*, contributed talk presented at the 10th Hvar Astrophysics Colloquium, Hvar, Croatia, September 6-10, 2010

107. **Gopalswamy, N.**, *Coronal mass ejections and solar radio emissions*, INVITED talk presented at the 7th International Workshop on Planetary, Solar and Heliospheric Radio Emissions (PRE VII), Graz, Vienna, September 15 - 17, 2010
108. **Gopalswamy, N.**, *Flux-Rope CDAW: Overview*, INVITED talk presented at the LWS CDAW on CME flux ropes, San Diego, California, September 22 – 25, 2010
109. Glesener, L., **S. Christe**, S. Krucker, *The Focusing Optics Solar Imager*, Next-Generation Suborbital Researchers Conference, Boulder, Colorado, 2010
110. Gonzales, A., Mink, R., and G. **Khazanov**, *Maximizing Utility for Ares V – Unpressurized Cargo and Secondary Missions for Heliocentric Observations*, Geophysical Research Abstracts, Vol. 12, EGU2010-0, 2010, EGU General Assembly 2010.
111. **Gurman, J.B.** 2010, *NASA's STEREO Mission*, NOAA Space Weather Workshop
112. Haaser, R.A., G.D. Earle, R.A. Heelis, W.R. Coley, J.H. **Klenzing**, and R. Stoneback, *A correlative study of ionospheric low latitude velocity and density irregularities during solar minimum*, contributed talk presented at **C/NOFS Science Workshop**, Breckenridge, Colorado, May 2010
113. Haaser, R.A., M.R. Hairston, W.R. Coley, R.A. Heelis, G.D. Earle, R. Stoneback, M.D. Perdue, and J.H. **Klenzing**, *Observations of a space shuttle burn by CINDI instruments on C/NOFS*, poster presented at **Fall AGU**, San Francisco, California, December 2009
114. Habbal, S. R., M. Druckmuller, H. Morgan, I. Scholl, V. Rusin, A. **Daw**, J. Johnson, and M. Arndt, *Hot Prominence Cavities*, contributed talk presented at **American Astronomical Society Meeting #216**, Miami, FL, May 2010
115. Henderson, M., and L. **Kepko**, *Substorms, poleward boundary activations, auroral streamers, omega bands, and geosynchronous particle injections during the December 11, 1998 sawtooth event*, contributed talk presented at the International Conference on Substorms-10, Pismo Beach, California, March 22-26, 2010.
116. **Hesse, M.**, *The structure of the electron outflow jet in collisionless magnetic reconnection*, 2008 Cambridge workshop on Magnetic Reconnection, Bad Honnef, Germany, August 2008.
117. **Hesse, M.**, *The electron diffusion region: Forces and currents*, Symposium on the occasion of the 75th birthday of Russell Kulsrud, Princeton University, Princeton, NJ, July 2008.
118. **Hesse, M.**, *On the onset of magnetic reconnection*, SHINE/GEM joint workshop, Zermatt, UT, July 2008
119. **Hesse, M.**, *On plasmoid acceleration in the magnetotail*, SHINE/GEM joint workshop, Zermatt, UT, July 2008
120. **Hesse, M.**, *The diffusion region and the electron outflow jet*, GEM 2008, Zermatt, UT, June 2008
121. **Hesse, M.**, *Real-time and event-based prediction capabilities of modern space science models*, Space Weather Workshop, Boulder, CO, April 2008.
122. **Hesse, M.**, *NASA Research missions: Applications for Space Weather forecasting*, Air Force Weather Agency planning workshop, Omaha, NE, April 2008.
123. **Hesse, M.**, *The dissipation mechanism of magnetic reconnection*, 2008 US-Japan Reconnection Workshop, Okinawa, Japan, March 2008.

124. **Hess Webber**, S.A., N. Karna, M.S. Kirk, and W.D. **Pesnell**, *An update of the automated detection of EUV polar coronal holes during Solar Cycle 23*, Poster presented at the SHINE 2010 Workshop, Sante Fe, NM, July 2010
125. Hill, F., J.B. **Gurman**, P. Martens, R. Bogart, A. Davey, J. **Hourclé**, F. Suárez Solá, V.K. **Hughitt**, J. Spencer, K. Reardon, and A. Amezcua, 2010, *SDO data access via the Virtual Solar Observatory*, AAS Meeting 216, #402.18, 2010AAS...21640218H
126. **Holman**, G.D., *Electron Beam Return-Current Losses in Solar Flares: Initial Comparison of Analytical and Numerical Results*, B.A.A.S., 42, 902, 2010.
127. **Hourclé**, J.A, *Interoperability in the Space Sciences, talk as part of the panel Standards and Best Practices in Scientific Data Management: Promoting Interoperability and Re-use* at the ASIS&T Annual Meeting, Vancouver, British Columbia, November 2009.
128. **Hourclé**, J.A., *Ignored Issues in e-Science: Collaboration, Provenance and the Ethics of Data*, poster IN31B-1008 at the Fall AGU Meeting, San Francisco, California, December 2009.
129. **Hourclé**, J., A. Amezcua, A. Davey, V.K. **Hughitt**, J. Spencer, I. Suárez-Solá, A. Somani, and the VSO Team, *Accessing SDO Data Through the VSO IDL Client*, poster 402.19 at the AAS/SPD meeting, Miami, Florida, May 2010.
130. **Hughitt**, V.K., **Hourclé**, J, Suárez-Solá, I., and A. Davey, *A Simple Customizable Web Interface to the Virtual Solar Observatory*, poster 402.20 at AAS/SPD meeting, Miami, Florida, May 2010.
131. **Hughitt**, V.K., J. **Ireland**, D. **Müller**, M. Langenberg, S. Pagel, L. Schmidt, J. Harper, G. **Dimitoglou**, and B. **Fleck**, *Solar Mashups: Interacting With, Extending, And Embedding Helioweb.org And Jhelioweb.org*, Solar Physics Division Meeting, Miami, Florida, 24-27 May 2010.
132. **Hughitt**, V.K., J. **Ireland**, D. **Mueller**, G. **Dimitoglou**, J. Garcia Ortiz, L. Schmidt, B. Wamsler, J. Beck, A. Alexanderian, B. **Fleck**, *Helioweb.org: Browsing Very Large Image Archives Online Using JPEG 2000*, Fall AGU meeting, San Francisco, California, 14-18 December 2009.
133. Hwang, K.-J., M.L., **Goldstein**, D.E. **Wendel**, and A. Fazakerle, September 2010, Cluster's 10th Anniversary-THEMIS science workshop, Corfu, Greece, *Observations of multiple near-X-line structures and electron diffusion region in Earth's magnetotail current sheet*
134. Hwang, K.J., M. L. **Goldstein**, and Y. **Wang**, July 2010, COSPAR international meeting, Bremen, Germany, *Observation of Magnetopause fluctuations during a Cluster-THEMIS conjunction*
135. Hwang, K.-J., M. L. **Goldstein**, and A. Fazakerley, July 2010, COSPAR international meeting, Bremen, Germany, *Observations of multiple near-X-line structures in Earth's magnetotail current sheet*
136. Hwang, K.-J., M. L. **Goldstein**, E. Lee, and J S. Pickett, March 2010, ICS substorm international meeting, San Luis Obispo, CA, *Cluster observations of multiple dipolarization fronts*
137. Hwang, K.-J., M. **Kuznetsova**, M.L. **Goldstein**, F. Sahraoui, E. Lee and G. K. Parks, December, 2009 AGU Fall meeting, San Francisco, CA, *Kelvin-Helmholtz Waves under Southward IMF*
138. Hwang, K.-J., M.L., **Goldstein**, E. Lee, and J. S. Pickett, December, 2009 AGU Fall meeting, San Francisco, CA, *Cluster observation of multiple Dipolarization Front (DF) events deforming mid-tail magnetic topology*
139. **Imber**, S., *Geotail observations of the dependence of the near-Earth neutral line location on solar activity*, Fall AGU, San Francisco CA, December 2009
140. **Imber**, S., *THEMIS observations of the average location of the near-Earth x-line*, International Conference on Substorms 10, San Luis Obispo, CA, March 2010.

141. **Imber, S.**, *THEMIS observations of the average location of the near-Earth x-line*, European Geophysical Union meeting, Vienna Austria, May 2010.
142. **Imber, S.**, *The Northern Lights: Illuminating Near-Earth Space*, University of Leicester Inaugural Lecture, May 2010.
143. **Imber, S.**, *Where does the near-Earth neutral line form, and why?* Geospace Environment Modelling Workshop, Snowmass CO, June 2010.
144. Immel, T. L., R. A. Heelis, J. Huba, J. Krall, R.F. **Pfaff**, and R.F. **Benson**, *Effects of the April 2002 magnetic storm on density gradients in the middle and low latitude ionosphere*, poster presented at the fall 2009 AGU meeting held from 14-18 December 2009 in San Francisco, California.
145. **Ireland, J.**, G.D. **Holman**, B.R. **Dennis**, A.K. **Tolbert**, and R.A. **Schwartz**, *Bayesian analysis of RHESSI spectra*, Eos (AGU Fall Meeting), SH21C-08, 2009; B.A.A.S., 42, 899, 2010.
146. **Ireland, J.**, A.K. **Tolbert**, G.D. **Holman**, R.A. **Schwartz**, and B.R. **Dennis**, *Bayesian analysis of RHESSI spectra*, Fall AGU meeting, San Francisco, California, 14-18 December 2009.
147. **Ireland, J.**, D.M. **Müller**, V.K. **Hughitt**, G. **Dimitoglou**, and B. **Fleck**, *The Helioviewer Project: Discovery for Everyone Everywhere*, SDO Science Working Group Meeting, Titusville, Florida, 6 February 2010.
148. **Ireland, J.**, A.K. **Tolbert**, G.D. **Holman**, R.A. **Schwartz**, and B.R. **Dennis**, *Bayesian analysis of RHESSI spectra*, Solar Physics Division Meeting, Miami, Florida, 24-27 May 2010.
149. **Ireland, J.** *Future directions in solar image processing*, Advanced Computational Capabilities for Exploration in Heliophysical Science, 16-18 August 2010.
150. **Ireland, J.** M.S. Marsh, T.A. **Kucera**, C.A. **Young**, *Automated Detection of Oscillating Regions in the Solar Atmosphere*, Fifth Solar Image Processing Workshop, Les Diablerets, Switzerland, 12-16 September 2010.
151. **Ireland, J.**, D.M. **Müller**, V.K. **Hughitt**, G. **Dimitoglou**, and B. **Fleck**, *Helioviewer Development Team, Converting FITS files to JPEG2000 for use with the Helioviewer Project*, SDO Data in Europe Meeting, Royal Observatory of Belgium, Brussels, Belgium, 17 September 2010
152. Israelevich, P., **Ofman, L.**, *Ion-acoustic Waves Excitation by a standing Alfvén wave*, Poster, 38th COSPAR Scientific Assembly, in Bremen, Germany, July 18-25, 2010
153. Jian, L.K., C.T. Russell, J.G. Luhmann, P. **MacNeice**, D. **Odstrcil**, and A.B. Galvin, *Comparison between Multi-Spacecraft Observations and Modeling: Stream Interaction Regions during March 2007 – March 2009*, Contributed talk, presented at COSPAR, Bremen, Germany, July 2010.
154. Johnson, R.E., T.A. Cassidy, A. R. Hendrix, C. Paranicas, F. Cipriani, F. Leblanc, and J. F. **Cooper**, *Jovian magnetospheric plasma effects at Europa and Ganymede*, INVITED talk SM11C-05 presented at **Fall 2009 AGU Meeting**, San Francisco, Ca, Dec. 14-18, 2009.
155. Jones G.H., E. Roussos, A.J. Coates, C.S. Arridge, S.J. Kanani, D.T. Young, N. Krupp, S. M. Krimigis, R.A. Baragiola, J. Berthelier, M.H. Burger, J. F. **Cooper**, F. J. Crary, R.E. Johnson, H.R. Martens, D.B. Reisenfeld, R.L. Tokar, and R.J. Wilson, *Rhea's interaction with Saturn's magnetosphere: evidence for a plasma source*, contributed talk P51C-1143 presented at **Fall 2009 AGU Meeting**, San Francisco, Ca, Dec. 14-18, 2009.
156. **Jones, S.I.**, and J.M. **Davila**, *Coronal Rotation Between 1.5 and 3.5 Solar Radii at Solar Minimum*, poster presented at Fall AGU Meeting, San Francisco, CA, December 2010

157. Joy, S., R.J. Walker, J. **Merka**, T. King, L. Bargatze, P. Chi, J. Weygand, and T. **Narock**, Getting data into NASA's HPDE Virtual Observatories, American Geophysical Union Fall Meeting, San Francisco, 2009.
158. **Jung**, H., N. **Gopalswamy**, S. **Akiyama**, and S. **Yashiro**, *Relation between Magnetic Helicity and CME Speed in Solar Source Regions*, poster presented at 2010 SHINE, Santa Fe, New Mexico, July 26-30, 2010
159. **Karpen**, J.T. C.R. DeVore, and S.K. **Antiochos**, *Reconnection Onset in the Breakout Model for CME Initiation*, poster presented at the Annual AAS/SPD meeting, Miami FL, 24-28 May 2010
160. **Karpen**, J.T., *CME Initiation and Reconnection*, INVITED talk presented at the Yosemite 2010 Magnetic Reconnection Workshop, Yosemite National Park CA, 8-12 February 2010
161. Kaufmann, P., **Holman**, G.D., Y. **Su**, C. Gimenez de Castro, E. Correia, R.V. de Souza, A. Marun, and P. Pereyra, *Unusual Emissions at Various Energies and Coronal Mass Ejection Prior to the November 4, 2003 Large Solar Flare*, B.A.A.S., 42, 905, 2010
162. **Kepko**, L., E. Spanswick, V. Angelopoulos, E. Donovan, J. McFadden, K.H. Glassmeier, J. Raeder, and H.J. Singer, *Equatorward moving auroral signatures of a flow burst observed prior to auroral onset*, contributed talk presented at the *Fall meeting of the American Geophysical Union*, San Francisco, California, December 2009
163. **Kepko**, L., V. Angelopoulos, C.T. Russell, K. Yumoto, H. Singer, K.H. Glassmeier, and J.P. McFadden, *THEMIS observations of directly-driven Pi2 pulsations*, contributed talk presented at the International Conference on Substorms-10, Pismo Beach, California, March 22-26, 2010.
164. **Kepko**, L., V. Angelopoulos, R. L. McPherron, S. Apatenkov, and K.H. Glassmeier, *Modeling Harris current sheets with THEMIS observations*, contributed poster presented at the International Conference on Substorms-10, Pismo Beach, California, March 22-26, 2010.
165. **Kepko**, L., E. Spanswick, V. Angelopoulos, and E. Donovan, *The relationship of magnetotail flow bursts and ground onset signatures*, INVITED talk presented at the Cluster 10th Anniversary workshop, Corfu, Greece, Sep 27 – Oct 1, 2010.
166. **Kepko**, L. *Auroral signatures of magnetospheric flow bursts*, INVITED talk presented at the Theory of the Magnetosphere Workshop, Oct 4 – 8, 2010
167. **Khazanov**, G.V., W. **Lyatsky**, and J.A. **Slavin**, *Alfven Wave - DC Dualism in the Description of Stationary Field-Aligned Currents*, AGU Fall Meeting, San Francisco, December 14-18, 2009.
168. **Khazanov**, G.V., W. **Lyatsky**, and J.A. **Slavin**, *A new solar wind-geomagnetic activity coupling function and its application to forecasting the major Geospace parameters*, Geophysical Research Abstracts, Vol. 12, EGU2010-0, 2010, EGU General Assembly 2010.
169. **Kilper**, G.K., & **Davila**, J.M., *Solar Prominence Dynamics Prior to Eruption*, poster, Fall AGU meeting 2009
170. **Kilper**, G.K. *Multi-viewpoint Observations of Prominence Eruptions*, contributed talk, STEREO WG 21 meeting
171. **Kilper**, G.K., and J.M. **Davila**, J. *Building a Complete Observational Picture of Quiet Sun Prominence Eruptions*, poster, AAS SPD meeting
172. **Kilper**, G.K. and J.M. **Davila**, *Multi-day Precursors to Prominence Eruptions*, poster, SHINE Workshop 2010

173. King, T.; R. Walker, **J. Merka**, R. Bentley, A. Roberts, R. Rankin, R. Candey, and T. **Narock**, *Science, VxOs and Just In Time Information*, American Geophysical Union Fall Meeting, San Francisco, 2009.
174. **Klenzing**, J.H. R.F. **Pfaff**, and F. **Simoes**, *The electrical properties of the atmosphere during the recent extreme solar minimum*, INVITED talk presented at **ISSI workshop on coupling between the Earth's atmosphere and its plasma environment**, Bern, Switzerland, September 2010
175. **Klenzing**, J.H., D.E. **Rowland**, R.F. **Pfaff**, G. **Le**, H.T. **Freudenreich**, K.R. **Bromund**, W.R. Coley, R.A. Haaser, A. G. Burrell, and P.A. Roddy, *Observations of plasma density enhancements in the low latitude ionosphere and associated plasma parameters and drifts from the C/NOFS satellite*, poster presented at **Meeting of the Americas**, Foz du Iguassu, Brazil, August 2010
176. **Klenzing**, J.H., I. **Seker**, R.F. **Pfaff**, D.E. **Rowland**, S.F. **Fung**, and P.A. Roddy, *Night-time F-region irregularities observed with the C/NOFS satellite and an all-sky imager at Arecibo Observatory*, poster and contributed talk presented at **CEDAR**, Colorado, June 2010
177. **Klenzing**, J.H., D.E. **Rowland**, J. Hill, A. T. Weatherwax, J. Kujawski, P. Uribe, S. Kholderbarin, L. Ramsey, R. Carrol, J. Williams, and J. DeMatteo, *Firefly: a CubeSat mission to study terrestrial gamma-ray flashes*, poster presented at **CEDAR**, Colorado, June 2010
178. **Klenzing**, J.H., D.E. **Rowland**, J. Hill, A. T. Weatherwax, J. Kujawski, P. Uribe, S. Kholderbarin, L. Ramsey, *Firefly: a CubeSat mission to study terrestrial gamma-ray flashes*, poster presented at **Fall AGU**, San Francisco, California, December 2009
179. **Klenzing**, J.H., D.E. **Rowland**, R.F. **Pfaff**, G. **Le**, H.T. **Freudenreich**, K.R. **Bromund**, W.R. Coley, R.A. Haaser, A. G. Burrell, and P.A. Roddy, *Observations of plasma density enhancements in the low latitude ionosphere and associated plasma parameters and drifts from the C/NOFS satellite*, contributed talk presented at **C/NOFS Science Workshop**, Breckenridge, Colorado, May 2010
180. **Klimchuk**, J. A., G. Nigro, R.B. Dahlburg, and S.K. **Antiochos**, *The Existence and Origin of Turbulence in Solar Active Regions*, contributed talk at **Fall AGU Meeting**, San Francisco, California, December 2009
181. **Klimchuk**, J. A., *Nanoflare Heating of the Solar Corona*, INVITED colloquium at the High Altitude Observatory, Boulder, Colorado, January 2010
182. **Klimchuk**, J.A., *The Existence and Origin of Turbulence in Solar Active Regions*, contributed talk at the **AAS/SPD Meeting**, Miami, Florida, May 2010
183. **Klimchuk**, J.A., *What I like best about being an astronomer*, INVITED talk at the AAS & SPD Student Reception, **AAS/SPD Meeting**, Miami, Florida, May 2010
184. **Klimchuk**, J.A., *Nanoflare Heating of Solar and Stellar Coronae*, INVITED talk at **COSPAR Meeting**, Bremen, Germany, July 2010
185. **Klimchuk**, J.A., *Nanoflares, Spicules, and Other Small-Scale Dynamic Phenomena on the Sun*, INVITED talk at **COSPAR Meeting**, Bremen, Germany, July 2010
186. **Klimchuk**, J.A., *Symposium Summary: Sunspots, Dynamo, Flares, Coronal and Chromospheric Heating*, INVITED talk at **IAU Symposium 273: Physics of Sun and Star Spots**, Ventura, California, August 2010
187. **Klimchuk**, J. A., and N.M. **Viall**, *Why We Need Spectroscopy to Solve the Coronal Heating Problem*, contributed talk at **Solar Plasma Spectroscopy: Achievements and Future Challenges**, Cambridge, UK, September 2010

188. **Koval** A., and A. **Szabo**, *Multi-spacecraft observations of interplanetary shock shapes*, poster presented at **EGU General Assembly**, Vienna, Austria, May 2010
189. **Koval**, A., and A. **Szabo**, *Multi-spacecraft observations of interplanetary shock parameters*, poster presented at **Fall AGU Meeting**, San Francisco, California, December 2009
190. Kozyra, J.U.; P.C. Brandt, N. **Buzulukova**, D. de Zeeuw, M.-C. H. Fok, H.U. Frey, S.E. Gibson, R. Ilie, M.W. Liemohn, S.B. Mende, L.J. Paxton, L. **Rastaetter**, A.J. Ridley, and M.F. Thomsen, *Are Unusual Solar Wind Conditions in SC23-24 Triggering Changes in the Geospace Response to High Speed Streams?*, contributed talk at **Fall AGU meeting**, San Francisco, December 2009
191. **Kucera**, T.A., S.E. Gibson, D. Rastawicki, J. Dove, G. de Toma, J. Hao, H.S. Hudson, S C. Marque, P.S. McIntosh, K.K. Reeves, D.J. Schmidt, A.C Sterling, D.K. Tripathi, D.R. Williams, and M. Zhang, *Geometric Model of a Coronal Cavity* poster presented at AAS/SPD meeting, Miami, Florida, May 23-27, 2010.
192. **Kuznetsova**, M., D. **Berrios**, A. **Chulaki**, M. **Hesse**, P. **MacNeice**, M. **Maddox**, A. **Pulkkinen**, L. **Rastätter**, and A. **Taktakishvili**, *Scientific Benefits of Space Science Models Archiving at Community Coordinated Modeling Center*, paper presented at the fall AGU, San Francisco, CA, December 14-18, 2009.
193. Laszlo, E., A.K. **Tolbert**, R.A. **Schwartz**, D.M. **Zarro**, B.R. **Dennis**, *Cloudy Solar Software - Enhanced Capabilities for Finding, Pre-processing, and Visualizing Solar Data*, Solar Physics Division (SPD), Miami, FL, 2010
194. Linker, J.A., P. Riley, Z. Mikic, R. Lionello, V.S. Titov, and D. **Odstrcil**, *CORHEL: A modeling suite for describing the solar corona and inner heliosphere*, presentation at **Fall AGU Meeting**, San Francisco, California, December 2009
195. **Lipatov**, A.S., and J.F. **Cooper**, *Hybrid kinetic modeling of the lunar plasma environment: past, present, and future*, contributed poster presented at Lunar Dust, Plasma & Atmosphere: The Next Steps, Boulder, Colorado, Jan. 27-29, 2010.
196. **Lipatov**, A. S., J. F. **Cooper**, and W. R. **Paterson**, *Jovian's plasma torus interaction with Europa: 3D hybrid kinetic simulation*, contributed talk presented at **Fall AGU Meeting**, San Francisco, CA, Dec. 13-18, 2009.
197. **Lipatov**, A. S., J.F. **Cooper**, and W.R. **Paterson**, *Jovian's plasma torus interaction with Europa. Effects of induced dipole moment: 3D hybrid kinetic simulation*, contributed poster presented at **European Geophysical Union General Assembly 2010**, Vienna, Austria, May 2-7, 2010.
198. **Lipatov**, A.S., E.C. **Sittler**, R.E. **Hartle**, D.G. **Simpson**, *Background and pickup ion velocity distribution dynamics in Titan's plasma environment: 3D hybrid simulation and comparison with observations*, COSPAR Assembly, July 17-24, 2010, Bremen, Germany, 2010. (Oral)
199. **Lipatov**, A.S., E.C. **Sittler**, R.E. **Hartle**, and D.G. **Simpson**, *Saturn's magnetosphere interaction with Titan for T9 encounter. Pickup ion velocity distribution: 3D hybrid simulation and comparison with CAPS's observations*, EGU General Assembly, May 2-7, 2010, Vienna, Austria. (Poster)
200. **Lipatov**, A.S., J.F. **Cooper**, and W.R. **Paterson**, *Jovian's plasma torus interaction with Europa*, Proceeding of Fall AGU Meeting, San Francisco, Dec. 14-18, 2009.
201. Lopez Fuentes, M., and J.A. **Klimchuk**, *A Cellular Automaton Nanoflare Model of Coronal Loops*, contributed talk at **COSPAR Meeting**, Bremen, Germany, July 2010

202. Lowman, P.D. and P.C. **Chen**, *Comparative Scientific Value of Manned Missions to the Moon and to an Asteroid*, poster presented at 3rd Lunar Science Forum, NASA Ames, Moffett Field, California, July 2010
203. **Luna Bannasar, M.;** J.T. **Karpen**, and C.R. DeVore, *Formation of a Multi-threaded prominence*, contributed talk presented at ISSI meeting: Solar Prominence Formation and Equilibrium: New Data, New Models, Bern, Switzerland, April 2010.
204. **Lyatsky, W.**, and G.V. **Khazanov**, Cross-Polar-Cap Potential as Derived from DMSP Data and AMIE Technique, AGU Fall Meeting, San Francisco, December 14-18, 2009.
205. Lynch, B.J., Y. Li, A.A. Reinard, K.K. Reeves, J.C. Allred, J.A. Linker, **MacNeice**, P.J. and Laming, J.M., *Ionic Composition Structure in 2.5D MHD CME Simulations*, Contributed talk presented at the American Astronomical Society Meeting, Miami, May 2010
206. **Mäkelä, P.**, *IP type III bursts with GLE*, contributed talk at LWS CDAW II: Ground Level Enhancement events at Huntsville, Alabama, November 2009
207. **McGuire, R E, D. Bilitza, R.M. Candey, R. Chimiak, J. F. Cooper, L N Garcia, B. Harris, R C Johnson, J.H. King, T. Kovalick, H. Leckner, M. Liu, N.E. Papitashvili, R Parthasarathy, and D.A. Roberts**, *An Updated Overview of SPDF Roles, Data and Services to the Heliophysics Community*, INVITED talk presented at AGU Fall meeting, San Francisco, December 2009
208. **MacNeice, P.**, M. **Hesse**, M. **Kuznetsova**, L. **Rastaetter**, and A.**Taktakishvili**, *Validation of Model Forecasts of the Ambient Solar Wind*, INVITED talk, presented at American Geophysical Union Fall Meeting, San Francisco, California, December 2009
209. **Mäkelä, P.**, N. **Gopalswamy**, H. **Xie**, S. **Akiyama**, and S. **Yashiro**, *Interplanetary Proton and Electron Enhancements Associated with Radio-loud and Radio-quiet CME-driven Shocks*, poster at Fall AGU meeting, San Francisco, California, December 2009
210. **Mäkelä, P.**, N. **Gopalswamy**, H. **Xie**, S. **Akiyama**, and S. **Yashiro**, *Type II radio emission and ESP events*, poster at **SHINE workshop**, Santa Fe, California, July 2010
211. **Mays, M. L.**, O.C. **St. Cyr**, and D.G. **Sibeck**, *Stream Interactions and CMEs in STEREO and THEMIS data and resulting geomagnetic activity*, presented at **COSPAR Scientific Assembly**, Bremen, Germany, July 2010
212. **Mays, M. L.**, O.C. **St. Cyr**, and D.G. **Sibeck**, *Stream Interactions and CMEs in STEREO and THEMIS data and resulting geomagnetic activity*, presented at **STEREO SWG-21**, Dublin, Ireland March 2010
213. **Mays, M.L.**, O.C. **St. Cyr**, D.G. **Sibeck**, H. Zhang, L. Jian, C.T. Russell, and J.G. Luhmann, *Stream Interactions and CMEs in STEREO and THEMIS Data and Resulting Geomagnetic Activity*, poster presented at **Fall AGU meeting**, San Francisco, California, December 2009
214. Melendez, M., Weaver, K. A., Kraemer, S., Mushotzky, R., Tueller, J., Markwardt, C., Malumuth, E., **Engle, K.**, Armus, L. Berghea, C. Dudik, R., Winter, L. 2010AAS...213541112M
215. **Merka, J.**, D. **Sibeck**, T.W. **Narock**, *Transient flows in the dayside magnetosheath: A search for THEMIS evidence made practical by the Virtual Magnetospheric Observatory*, European Geosciences Union General Assembly 2010, Vienna, Austria, 2–7 May 2010
216. **Merka, J.**, A. **Szabo**, R. Walker, T. **Narock**, T. King, J. Faden, *Symbiosis of Data Archives and Virtual Observatories*, American Geophysical Union Fall Meeting, San Francisco, 2009.

217. **Merka, J., D.G. Sibeck,** and T.W. **Narock** (2010). *A Statistical Study of THEMIS-observed Transient Flows in the Dayside Magnetosheath Enabled by the Virtual Magnetospheric Observatory*. Eos Trans. AGU 91(26), Meet. Am. Suppl., Abstract SM42A-04.
218. **Merka, J., Y. Wang,** and D.G. **Sibeck,** *3D Bow Shock Modeling Based on Multi-Spacecraft Observations and Support Vector Regression Machine*, contributed talk presented at 2010 GEM Summer Workshop, Snowmass, Colorado, June 2010.
219. Mertens, C. J. and D. **Bilitza,** *Empirical Geomagnetic Storm Correction to IRI E-Region Electron Density Using TIMED/SABER Data*, INVITED talk presented at the IRI Workshop, Kagoshima, Japan, November 2009.
220. **Mitchell, E. J., R.E. Lopez, M.-C. H. Fok,** M. Wiltberger, and J. Lyon, *Lack of Ring Current Response to Large Y-Component Interplanetary Magnetic Field*, INVITED talk presented at **Asia Oceania Geosciences Society (AOGS)**, Hyberabad, India, July 2010
221. **Mitchell, E. J., R. E. Lopez, R. J. Bruntz,** and Y. Deng, *Evidence that IMF By decouples energy input into the ionosphere from energy input into the inner magnetosphere*, INVITED talk presented at **Geospace Environment Modeling Workshop**, Snowmass, CO, June 2010
222. **Mitchell, E. J.,** *The role of the Y-component of the Interplanetary Magnetic Field in Transpolar Potential Saturation and Ring Current Response as found in Data and Simulation*, INVITED talk presented at **NASA Goddard Heliophysics Science Division: Director's Seminar**, Greenbelt, MD, February 2010
223. **Mitchell, E.J., R.E. Lopez, M.J. Wiltberger, J.G. Lyon, R.C. Allen,** and P.L. Whittlesey, *The Lack of Ring Current Response to Large Y-Component IMF*, poster presented at **American Geophysical Union Fall Meeting**, San Francisco, CA, December 2009
224. Mohamed A., P. **Mäkelä, N. Gopalswamy, S. Yashiro, S. Akiyama, H. Xie,** and H. **Jung,** *Coronal hole influence on MCs and non-MCs*, contributed talk at **LWS CDAW: Do All CMEs have Flux Rope Structure?**, San Diego, California, September 2010
225. **Moore, T. E., G. V. Khazanov, M.C. H. Fok, A. Glocer,** *Mechanisms of Ionospheric Mass Ejection*, 2010 Western Pacific Geophysics Meeting, June 22-25, Taipei, Taiwan **INVITED**.
226. **Moore, T.E.,** 2009 AGUFM, *Physical Processes for Driving Ionospheric Outflows in Global Simulations*, Eos Trans. Am. Geophys. Un.
227. **Moore, T.E., G.V. Khazanov,** 2010 AGUFM, *Understanding Meso- and Micro-scale Coupling of Near Earth Plasmas*, Eos Trans. Am. Geophys. Un.
228. **Mueller, D., G. Dimitoglou, V.K. Hughitt, J. Ireland, B. Wamsler,** and B. **Fleck,** *A Novel Approach to Discovery and Access to Solar Data in the Petabyte Age*, Fall AGU meeting, San Francisco, California, 14-18 December 2009.
229. **Mueller, D., M. Langenberg, S. Pagel, L. Schmidt, J.P. Garcia Ortiz, G. Dimitoglou, V.K. Hughitt, J. Ireland,** and B. **Fleck,** *JHeliviewer: Taming The Torrent Of SDO Data*, Solar Physics Division Meeting, Miami, Florida, 24-27 May 2010.
230. **Mueller, D, V.K. Hughitt, M. Langenberg, J. Ireland, S. Pagel, L. Schmidt, Garcia Ortiz, J. P., G. Dimitoglou,** and B. **Fleck,** *The Heliviewer Project: Browsing, Visualizing and Accessing Petabytes of Solar Data*, Solar Physics Division Meeting, Miami, Florida, 24-27 May 2010.
231. Mulu, F., Winebarger, A., and J. A. **Klimchuk,** *Determining the Temperature Structure of Solar Coronal Loops using their Temporal Evolution*, contributed talk at the **AAS/SPD Meeting**, Miami, Florida, May 2010

232. **Narock, T., J. Merka,** and **A. Szabo,** *Towards a Unified Heliophysics Data Environment*, American Geophysical Union Fall Meeting, San Francisco, 2009.
233. **Narock, T.** and **V. Yoon;** *Context and Subjectivity in Semantic e-Science*, American Geophysical Union Fall Meeting, San Francisco, 2009.
234. **Nieves-Chinchilla T.,** **A. Vourlidas,** **R. Gómez-Herrero,** **O. Malandraki,** **A. Szabo,** **A. F. Viñas,** **N. Dresing** and **J.M. Davila,** *Propagation and evolution of CMEs in the interplanetary medium: analysis of remote sensing and in situ observations*, poster presented at the Spring AGU- Meeting, Foz do Iguacu, Brazil, August 2010.
235. **Nitta, N.,** **M. Aschwanden,** **S. Freeland,** **J. Lemen,** **J.P. Wuelser,** and **D.M. Zarro,** *CME-related Phenomena and Solar Flares*, Advances in Space Research, Bremen, Germany, 2010
236. **Nitta, N.,** **M. Aschwanden,** **Z.A. Frank,** **G.L. Slater,** **T.D. Tarbell,** and **D.M. Zarro,** *Joint STEREO-HINODE Observations of Coronal Dimming and Waves Associated with a CME/Flare Event*, Advances in Space Research, Bremen, Germany, 2010
237. **Nitta, N.,** **M. Aschwanden,** **S. Freeland,** **J. Lemen,** **J.P. Wuelser,** **D.M. Zarro,** *Coronal Dimming And Waves Observed In Flare-Associated CMEs*, Solar Physics Division (SPD), Miami, FL, 2010
238. **Odstrcil, D.,** *Validation of numerical simulations of interplanetary CMEs using STEREO observations*, INVITED presentation at **Fall AGU Meeting**, San Francisco, California, December 2009
239. **Odstrcil, D.,** *Numerical simulations of ICMEs initialized by coronagraph observations*, presentation at **ACE/SOHO/STEREO/WIND Workshop**, Kennebunkport, Maine, June 2010. [FY2009]
240. **Odstrcil, D.,** **C.N. Arge,** **A. Rasca,** **A. Thernisien,** and **H. Xie,** *Simulation of heliospheric disturbances initialized by various fitting techniques*, poster at **Space Weather Workshop**, Boulder, Colorado, April 2010
241. **Odstrcil, D.,** **D. Baker,** **B.J. Anderson,** **L.R. Mayer,** **J.A. Slavin,** and **S.C. Solomon,** *The space environment of Mercury at the time of the third Messenger flyby: Solar wind and IMF modeling of upstream conditions*, presentation at **Fall AGU Meeting**, San Francisco, California, December 2009
242. **Ofman, L.,** **Gedalin, M.,** *Two-dimensional Hybrid model of Collisionless Relaxation of Ion Distributions downstream of Quasi-perpendicular Shocks*, Talk, AGU Meeting, San Francisco California, December 14-18, 2009.
243. **Ofman, L.,** **J. Schmidt,** **T.J. Wang,** *Three-dimensional MHD Model Of Active Region Loop Oscillations With Background Flow*, Talk, AAS/SPD meeting, Miami, FL, USA, May 23-27, 2010.
244. **Ofman, L.,** *Hybrid models of solar wind plasma heating*, Talk, *Dynamical Processes in Space Plasmas*, INVITED talk, Israel, April 10-17, 2010.
245. **Ofman, L.,** **J.M. Schmidt,** **T.J. Wang,** *Coronal active region loop oscillations with background flow*, Talk, BUKS 2010 Meeting at St Andrews University, June 9-11, 2010.
246. **Ofman, L.,** **L. Abbo,** **S. Giordano,** **M. Kramar,** *Comparison of observations and multi fluid models of streamers at solar minimum*, Talk, 38th COSPAR Scientific Assembly, in Bremen, Germany, July 18-25, 2010.
247. **Ogilvie, K.W.,** and **D.A. Roberts,** *The Relationship between ICMEs and Extremely Low Density Events in the Solar Wind*
248. **Onsager, T.G.,** **J.K. Kunches,** **P. MacNeice,** **V.J. Pizzo,** and **H.J. Singer,** *Recent Progress in Applying Research Advances to Operational Needs*, Contributed talk, presented at COSPAR, Bremen, Germany, July 2010.

249. **Osherovich, V.**, *New method to predict amplitude of next solar cycle*, NASA/GSFC HSD Seminar.
250. **Osherovich, V.**, *Type III Radio Burst Structure*, NASA/GSFC HSD Seminar
251. **Pesnell, W.D.**, *The Solar Dynamics Observatory and the wait for Solar Cycle 24*, ILWS 2009 Conference, Ubatuba, Brazil, October 8, 2009
252. **Pesnell, W. D.**, *What is solar minimum and why do we care?* ILWS 2009 Conference, Ubatuba, Brazil, October 9, 2009
253. **Pesnell, W.D.**, *What is solar minimum and why do we care?* THEMIS Lunch Telecon, NASA GSFC, Greenbelt, MD, October 20, 2009
254. **Pesnell, W.D.**, *Why NASA studies the Sun*, Astronomy Day 2009, Owens Science Center, Lanham, MD, October 24, 2009
255. **Pesnell, W.D.**, *What is solar minimum and why do we care?* Space and Cosmic Ray Physics Seminars, University of Maryland, College Park, MD, November 2, 2009
256. **Pesnell, W.D.**, *Spectra and SDO*, SDO E/PO Teacher's Workshop, NASA GSFC, Greenbelt, MD, November 30, 2009
257. **Pesnell, W.D.**, *The Solar Dynamics Observatory: Waiting for Solar Cycle 24*, NASA Heliophysics Booth, Fall 2009 Meeting of the AGU, San Francisco, CA, December 16, 2009
258. **Pesnell, W.D.**, *The Solar Dynamics Observatory: Ready for launch and Solar Cycle 24*, Special Seminar, NASA Goddard Space Flight Center, Greenbelt, MD, January 26, 2010
259. **Pesnell, W.D.**, *Heliogeismology and SDO*, SDO E/PO Teacher's Workshop, UCF Building, KSC Visitor Center, Titusville, FL, January 30, 2010
260. **Pesnell, W.D.**, *Introduction to the Solar Dynamics Observatory*, SDO E/PO Teacher's Workshop, UCF Building, KSC Visitor Center, Titusville, FL, January 30, 2010
261. **Pesnell, W. D.**, *The Solar Dynamics Observatory: Ready for launch and Solar Cycle 24*, Department of Physics, University of Florida, Gainesville, FL, February 1, 2010
262. **Pesnell, W.D.**, *The Solar Dynamics Observatory: Built and ready to GO!*, Astronaut Encounter Auditorium, KSC Visitor Center, Titusville, FL, February 8, 2010
263. **Pesnell, W. D.**, *The Solar Dynamics Observatory: Built and ready to GO!*, Heliophysics Subcommittee, NASA HQ, Washington, DC, February 17, 2010
264. **Pesnell, W.D.**, *The Solar Dynamics Observatory: Built and on station*, DLN Virtual Breaking News, Greenbelt, MD, March 17, 2010
265. **Pesnell, W.D.**, *Out to launch: Working at NASA GSFC*, Goddard New Hires, Goddard Space Flight Center, Greenbelt, MD, March 23, 2010
266. **Pesnell, W.D.**, *The Solar Dynamics Observatory: Your on-orbit eye on the Sun*, Space Weather Workshop, Boulder, CO, April 27, 2010
267. **Pesnell, W.D.**, *The Solar Dynamics Observatory: Your on-orbit eye on the Sun*, JHU Applied Physics Laboratory, Laurel, MD, May 10, 2010
268. **Pesnell, W.D.**, *The Solar Dynamics Observatory: Your on-orbit eye on the Sun*, Engineering Colloquium, Goddard Space Flight Center, Greenbelt, MD, May 17, 2010
269. **Pesnell, W.D.**, *The Solar Dynamics Observatory: Your on-orbit eye on the Sun*, SORCE Team Meeting, Keystone, CO, May 21, 2010

270. **Pesnell, W.D.**, *The Solar Dynamics Observatory: Your on-orbit eye on the Sun*, Public Lecture at the 216th AAS Meeting, Miami, FL, May 24, 2010
271. **Pesnell, W.D.**, *Extreme Space Weather, Panel presentation at the Science Jamboree*, Goddard Space Flight Center, Greenbelt, MD, June 2010
272. **Pesnell, W.D.**, *The Solar Dynamics Observatory: On orbit and ready for Solar Cycle 24*, Los Alamos National Laboratory, Los Alamos, NM, July 26, 2010
273. **Pesnell, W D.**, *Solar Cycle Prediction: Where are we and how did we get here?*, Plenary talk at the SHINE workshop, Santa Fe, NM, July 27, 2010
274. **Pesnell, W.D.**, *The Solar Dynamics Observatory: On orbit and ready for Solar Cycle 24*, INVITED talk at RHESSI Meeting X, Annapolis, MD, August 2, 2010
275. **Pesnell, W.D.** and P E. **Williams**, *Comparisons of photospheric convection cell characteristics*, Abstract SH11A-1500, poster presented at the Fall 2010 Meeting of the AGU, December 2009.
276. **Pfaff, R.F.**, H.T. **Freudenreich**, J.H. **Klenzing**, D.E. **Rowland**, and K.R. **Bromund**, *DC electric fields and their association with plasma densities as observed on the C/NOFS satellite*, INVITED talk presented at **Meeting of the Americas**, Foz du Iguassu, Brazil, August 2010
277. **Pfaff, R.**, J. **Klenzing**, D. **Rowland**, H. **Freudenreich**, K. **Bromund**, C. **Liebrecht**, P. Roddy, and D. Hunton, *Electric field and plasma density structures observed with the C/NOFS satellite during solar minimum conditions*, contributed talk presented at **C/NOFS Science Workshop**, Breckenridge, Colorado, May 2010
278. **Pfaff, R.**, P. **Schuck**, and J. **Klenzing**, *VLF and HF plasma waves associated with spread-F depletions observed on the C/NOFS satellite*, contributed talk presented at **USNC-URSI National Radio Science Meeting**, Boulder, Colorado, January 2010
279. **Pfaff, R.**, D. **Rowland**, J. **Klenzing**, H. **Freudenreich**, C. **Liebrecht**, and P. Roddy, *Structured DC electric fields with and without associated plasma density gradients observed with the C/NOFS satellite*, contributed talk presented at **Fall AGU**, San Francisco, California, December 2009
280. Plunkett, S.P., B.E. Wood, D. **Odstrcil**, P. Riley, **B.J. Thompson**, and A. **Szabo**, *Evolution of CMEs in the heliosphere at solar minimum*, poster at **Fall AGU Meeting**, San Francisco, California, December 2009
281. **Pulkkinen, A.**, M. **Hesse**, M., S. Habib, F. Policelli, B. Damsky, L. Van der Zel, D. Fugate, and W. Jacobs, *Solar Shield – Forecasting and Mitigating Space Weather Effects on High-Voltage Power Transmission Systems*, INVITED presentation at IEEE Seminar Series, TVA, Chattanooga, TN, December 10, 2009.
282. **Pulkkinen, A.**, M. **Kuznetsova**, A. Ridley, J. Raeder, D. Weimer, R. Weigel, M. Wiltberger, G. Millward, L. **Rastätter**, M. **Hesse**, M., H. J. Singer and A. **Chulaki**, *GEM 2008-2009 Challenge: ground magnetic field perturbations*, INVITED presentation at the Mini GEM Workshop, San Francisco, CA, December 13, 2009.
283. **Pulkkinen, A.**, A. **Taktakishvili**, and T. Oates, *Automatic determination of the conic coronal mass ejection model parameters*, paper presented at the fall AGU, San Francisco, CA, December 14-18, 2009.
284. **Pulkkinen, A.**, CCMC's V&V Report: *Magnetosphere/Ionosphere Models*, INVITED presentation at the CCMC Workshop, Key Largo, FL, January 25-29, 2010.

285. **Pulkkinen, A.**, *Usage of modern physics-based models in space weather forecasting: current capabilities and future prospects*, INVITED presentation at the Embry-Riddle Aeronautical University, Daytona Beach, FL, February 2, 2010.
286. **Pulkkinen, A.**, **A. Taktakishvili**, and T. Oates, *Automatic determination of the conic coronal mass ejection model parameters*, paper presented at the Space Weather Workshop, Boulder, CO, April 27-30, 2010.
287. **Pulkkinen, A.**, **M. Hesse**, S. Habib, L. Van der Zel, B. Damsky, F. Policelli, D. Fugate, W. Jacobs and E. Creamer, *Solar Shield project - lessons learned and advances made*, INVITED presentation at the Space Weather Workshop, Boulder, CO, April 27-30, 2010.
288. **Pulkkinen, A.**, *Geomagnetically induced currents – physics and applications*, INVITED tutorial presented at the GEM Summer Workshop, Snowmass, CO, June 20-25, 2010.
289. **Pulkkinen, A.**, *The Community Coordinated Modeling Center (CCMC): A Brief User's Guide*, INVITED tutorial presented at the CISM Summer School, Boston, MA, July 19-30, 2010.
290. **Pulkkinen, A.**, *Geomagnetically induced currents – physics and applications*, INVITED tutorial presented at the CISM Summer School, Boston, MA, July 19-30, 2010.
291. **Pulkkinen, A.**, **M. Hesse**, M., S. Habib, L. Van der Zel, B. Damsky, F. Policelli, D. Fugate, W. Jacobs and E. Creamer, *Solar Shield project - lessons learned and advances made*, INVITED presentation at the Finnish Meteorological Institute, Helsinki, Finland, August 5, 2010.
292. **Pulkkinen, A.**, **M. Hesse**, M., S. Habib, L. Van der Zel, B. Damsky, F. Policelli, D. Fugate, W. Jacobs, and E. Creamer, *Solar Shield: Forecasting and Mitigating Solar Effects on the North American Power Transmissions System*, presentation at the Catholic University, Physics Department, Washington, DC, September 22, 2010
293. **Rastaetter, L.**, **M.M. Kuznetsova**: *Metrics computations: Magnetopause crossings*, talk presented at GEM mini workshop, San Francisco, CA, December 2009.
294. **Rastaetter, L.**, **M.M. Kuznetsova**, **M. Hesse, M.**, **A. Chulaki**, **A. Pulkkinen**, H. Singer (NOAA), M. Thompson, A. Ridley, G. Millward, A. Vapirev, M. Wiltberger, *Inner-Magnetospheric Magnetic Fields*, talk presented at GEM mini workshop, San Francisco, CA, December, 2009.
295. **Rastaetter, L.**, **M.M. Kuznetsova**, **M. Hesse, M.**, *Establishing Connections between Magnetospheric Features and Ionospheric Observations through CCMC Simulations*, poster presented at **AGU Fall Meeting**, San Francisco, CA, December 2009.
296. **Rastaetter, L.**, **M.M. Kuznetsova**, **A. Pulkkinen**, **A. Chulaki**, J. Raeder, A. Vapirev, T. Gombosi, A. Ridley, R. Weigel, D. Welling, *DST index in 2008 GEM modeling challenge*, talk presented at **GEM summer workshop**, Snowmass, CO, June 2010.
297. **Rastaetter, L.**, **M.M. Kuznetsova**, **A. Pulkkinen**, **A. Chulaki**, J. Raeder, A. Vapirev, T. Gombosi, A. Ridley, M. Wiltberger, V. Merkin, I. Honkonen, *Magnetopause standoff in 2009 GEM modeling challenge*, talk presented at GEM summer workshop, Snowmass, CO, June 2010.
298. Reich, J., J. Cox, R. Davila, A. Parsons, M. **Kuznetsova**, D. Berrios, M. **Hesse**, **A. Pulkkinen**, **P. MacNeice**, **M. Maddox**, **L. Rastätter**, and **A. Taktakishvili**, *AFWA-CCMC Partnership to Augment USAF Space Weather Forecasting Capabilities*, paper presented at the fall AGU, San Francisco, CA, December 14-18, 2009.
299. Reinisch, B., P. Nsumei, D. **Bilitza**, X. Huang, *The Vary-Chap Topside Electron Density Model for IRI*, INVITED talk presented at the IRI Workshop, Kagoshima, Japan, November 2009.

300. Reeves, K., S.E. Gibson, T.A. **Kucera**, H.S. Hudson, and D. Tripathi, *Thermal Properties of Coronal Cavities as Observed by the X-Ray Telescope on Hinode* poster presented at AAS/SPD meeting, Maimi Florida, May 23-27, 2010.
301. **Retherford, K. D., J. F. Cooper, C. Paranicas, R. E. Johnson, E.C. Sittler, Jr., R.E. Hartle, M.A. McGrath, D. Pascu**, *Space weathering impact on solar system surfaces - community white paper for Planetary Science Decadal Survey 2009 – 2011*, contributed poster 41.16.08 presented at 41st Annual Meeting of the Division for Planetary Sciences of the American Astronomical Society, Fajardo, Puerto Rico, Oct. 4-9, 2009.
302. Richards, R. and D. **Bilitza**, *A new model for ionospheric molecular ion concentrations*, contributed talk presented at the IRI Workshop, Kagoshima, Japan, November 2009.
303. **Roberts, D.A.**, *Persistence in Solar Wind Fluctuations, a Virtual Observatory Assisted Study*
304. **Roberts, D.A.**, *Demonstrations that the Solar Wind is Not Accelerated by Waves or Turbulence* (INVITED presentation)
305. **Roberts, D.A.**, *The Evolution of the Spectrum of Velocity Fluctuations in the Solar Wind from 0.3 to 5 AU*
306. **Rowland, D.E., A.T. Weatherwax, J.H. Klenzing, and J. Hill**, *The NSF Firefly CubeSat: progress and status*, contributed talk presented at Fall AGU, San Francisco, California, December 2009
307. **Saba, J.L.R., and K.T. Strong**, *Comparing the evolution of solar cycles 21, 22, and 23 via a sensitive magnetic ratio*, poster and contributed talk presented at SOHO-23: Understanding a Peculiar Solar Minimum, Northeast Harbor, Maine, September 2009
308. Saint-Hilaire, P., **S. Christe**, J. McTiernan, B. Welsh, *Relationship between flare X-rays and photospheric magnetic fields*, Fall AGU 2009, San Francisco, California
309. **Sarantos, M., R. Killen, M. Benna, D. Glenar, T. Stubbs**, *Detectability of lunar exospheric constituents: simulations for LADEE*. EGU General Assembly, Vienna, Austria, May 2010.
310. **Sarantos, M., R. Killen, R. W. McClintock, E.T. Bradley, M. Benna, J.A. Slavin, and S. Solomon**, *Limits to Mercury's magnesium exosphere from MESSENGER second flyby observations*. EGU General Assembly, Vienna, Austria, May 2010.
311. **Sarantos, M., J.A. Slavin, M. Benna, R.M. Killen, W.E. McClintock, J.M. Raines, S.C. Solomon, D. Schriver, and P.M. Travnicek**, *Sodium and magnesium neutral and ion species at Mercury: Simulations and comparison to MESSENGER observations*. Fall 2009 AGU Meeting, San Francisco, CA, December 2009
312. Schmidlin, F.J. and R.A. **Goldberg**, *Temperature Measurement Comparability in the Presence of a Stratospheric Warming*.
313. Schnidt, M., D. Dettmering, R Heinkelmann, and D **Bilitza**, *Regional ionospheric modeling from the combination of different satellite observation techniques*, poster presented at the IRI Workshop, Kagoshima, Japan, November 2009.
314. **Schmidt, J.M., and L. Ofman**, *Global simulation of an EIT wave*, Poster, AGU Meeting, San Francisco California, December 14-18, 2009.
315. **Schmidt, J.M., and L. Ofman**, *Three-dimensional MHD Modeling Of Waves In Active Regions: Comparison To Observations*, Poster, AAS/SPD meeting, Miami, FL, USA, May 23-27, 2010.

316. **Schuck**, P.W., R.F. **Pfaff**, K.R. **Bromund**, P.A. Bernhardt, and J. **Klenzing**, *Active experiments in the ionosphere using chemical releases from the space shuttle and rockets*, contributed talk presented at USNC-URSI National Radio Science Meeting, Boulder, Colorado, January 2010
317. **Schuck**, P.W., R.F. **Pfaff**, K.R. **Bromund**, J.H. **Klenzing**, and P.A. Bernhardt, *Remote electrodynamic signatures of a pulsed shuttle exhaust plume detected by the C/NOFS Vector Electric Field Investigation probes*, poster presented at Fall AGU, San Francisco, California, December 2009
318. **Schuck**, P.W., *Understanding Solar Eruptions with SDO/HMI: Measuring Photospheric Flows, Testing Models, and Steps Towards Forecasting Solar Eruptions*, NASA Headquarters, 20 January 2010.
319. **Schuck**, P.W., *Understanding Solar Eruptions with SDO/HMI: Measuring Photospheric Flows, Testing Models, and Steps towards Forecasting Solar Eruptions*, NJIT, April 1st, 2010.
320. **Schuck**, P. W., M. Linton, K. **Muglach**, and T. Hoeksema, *Understanding Solar Eruptions with SDO/HMI Measuring Photospheric Flows, Testing Models, and Steps Towards Forecasting Solar Eruptions*, American Astronomical Society, AAS Meeting, Miami, Florida, #216, #402.14
321. **Schuck**, P. W.; Pfaff, R. F.; Bromund, K. R.; Bernhardt, P. A., *Remote Electrodynamic Signatures of a Pulsed Shuttle Exhaust Plume Detected by the C/NOFS Vector Electric Field Investigation Probes*, American Geophysical Union, Fall Meeting 2009, San Francisco, California, abstract# SA21A-1439.
322. **Seker**, I., J.H. **Klenzing**, S.F. **Fung**, R.F. **Pfaff**, and D.E. **Rowland**, *Night-time F-region plasma irregularities observed with an all-sky imager at Arecibo Observatory and the C/NOFS satellite*, contributed talk presented at **C/NOFS Science Workshop**, Breckenridge, Colorado, May 2010
323. **Seker**, I., S.F. **Fung**, and J.D. Mathews, *The relation between magnetospheric state parameters and the occurrence of night-time mid-latitude plasma depletions in the F-region*, poster, CEDAR workshop, Boulder, CO, June 2010.
324. **Seker**, I. and W. E. Swartz, *Animations of all-sky 630 nm and 3D electron densities through a night above the Arecibo Observatory*, contributed talk, CEDAR workshop, Boulder, CO, June 2010.
325. **Seker**, I., J. H. **Klenzing**, S.F. **Fung**, R.F. **Pfaff**, D.E. **Rowland**, *Mid-latitude F-region plasma irregularities observed with an all-sky Imager at Arecibo Observatory and the C/NOFS satellite*, contributed talk, Workshop on C/NOFS results and equatorial dynamics, Breckenridge, CO, May 2010.
326. **Seker**, I., *The properties and 3D structure of Medium-Scale Traveling Ionospheric Disturbances*, contributed talk, NASA Heliophysics Science Division Weekly Seminar, GSFC, Greenbelt, MD, March 2010.
327. **Seker**, I., S F. **Fung**, and J.D. Mathews, *The relation between magnetospheric state parameters and the occurrence of night-time mid-latitude plasma depletions in the F-region*, poster, AGU Fall Meeting, San Francisco, CA, December 2009.
328. Selwa, M., S. Solanki, L. **Ofman**, *Symmetry breaking in 3D active region: why are vertical kink oscillations observed so rarely?* Talk, BUKS 2010 Meeting at St. Andrews University, June 9-11, 2010.
329. **Shih**, A.Y., R.P. Lin, and B.R. **Dennis**, *Comparing solar flares with and without proportional acceleration of >-20 MeV protons and electrons above various energies*, poster presented at the 2009 Fall AGU Meeting, Miami, Florida, 15 December 2009
330. **Shih**, A. Y., B. R. **Dennis**, and R. P. Lin, *Comparing solar-flare acceleration of >-20 MeV protons and electrons above various energies*, contributed talk presented at the 216th AAS Meeting, Miami, Florida, 26 May 2010

331. **Shim, J. S.**, L. Scherliess, S.F., *Climatology of plasmaspheric TEC obtained from Jason-1*, poster presented at Fall **AGU** meeting, San Francisco, California, 14-18 December, 2009
332. **Shim, J.S.**, M.M. **Kuznetsova**, M. **Hesse**, A. **Chulaki**, and L. **Rastaetter**, *Ionosphere-Thermosphere Models at Community Coordinated Modeling Center*, poster presented at *Air Force Orbital Resources Ionosphere Conference*, Dayton, Ohio, 12-14 January 2010
333. **Shim, J.S.**, M. M. **Kuznetsova**, M. **Hesse**, M., A. **Chulaki**, and L. **Rastaetter**, *Ionosphere-Thermosphere Models at Community Coordinated Modeling Center*, poster presented at Space Weather Workshop, Boulder, Colorado, 27-30 April 2010
334. **Shim, J. S.**, M. M. **Kuznetsova**, L. **Rastaetter**, M. **Hesse**, M., and A. Chulaki, *CCMC Research and Education Resources for the CEDAR Community*, INVITED talk presented at CEDAR 2010 Workshop, Boulder, Colorado, 20-25 June 2010
335. **Shim, J.S.**, M. M. **Kuznetsova**, L. **Rastaetter**, M. **Hesse**, M., A. **Chulaki**, A. **Pulkkinen**, D. **Bilitza**, M. Codrescu, B. Emery, B. Foster, T. Fuller-Rowell, J. Huba, A. Ridley, R. Schunk, D.C. Thompson, D. Anderson, J. Chau, J. M. Forbes, J. Sojka, E. Sutton, B. Rideout, *CEDAR ETI (Electrodynamics Thermosphere ionosphere) Challenge*, talk presented at CEDAR 2010 Workshop, Boulder, Colorado, 20-25 June 2010
336. **Sibeck, D.G.**, and J. **Merka** (2009). *Active missions and the VxOs with THEMIS as an example*. Eos Trans. AGU, 90,(52), Fall Meet. Suppl., Abstract SH54A-02.
337. **Simoës, F**, R.F. **Pfaff**, J. **Klenzing**, and the VEFI team, *LF waves and the troposphere-ionosphere coupling*, INVITED talk presented at **ISSI workshop on coupling between the Earth's atmosphere and its plasma environment**, Bern, Switzerland, September 2010
338. **Simões, F.**, R.F. **Pfaff**, J.J. Berthelier, *Investigation of tropospheric-ionospheric coupling mechanisms from lightning activity*, AE43A-0255, American Geophysical Union, San Francisco, California, 2010 (poster)
339. **Simões, F.**, J.J. Berthelier, and R.F. **Pfaff**, *Observation and modeling of the Earth-ionosphere cavity electromagnetic transverse resonance and variation of the D-region electron density near sunset*, International Union of Radio Science, Boulder, Colorado, 2010 (talk)
340. **Simões, F.**, *Lightning-induced low frequency electromagnetic waves in planetary atmospheres*, Japanese Geosciences Union, Chiba, Japan, 2010 (INVITED talk)
341. **Simões, F.**, R.F. **Pfaff**, and the VEFI Team, *Overview of VEFI low frequency electromagnetic wave measurements onboard C/NOFS*, Workshop on C/NOFS Data Analysis and Modeling, Breckenridge, Colorado, 2010 (talk)
342. **Simpson, D.G.**, A.S. Lipatov, E.C. **Sittler, Jr.**, and R.E. **Hartle**, *Saturn's magnetosphere interaction with Titan for T9 encounter: 3D hybrid simulation and comparison with CAPS's observations*, Proceeding of Fall AGU Meeting, San Francisco, Dec. 14-18, 2009. (Poster)
343. Sipes, T., H. Karimabadi, and D. A. **Roberts**, *The MineTool Software Suite: A Novel Data Mining Palette of Tools for Automated Modeling of Space Physics Data*
344. **Sittler, Jr.**, E. C., R E. **Hartle**, J.F. **Cooper**, R. E. Johnson, H.T. Smith, M. **Shappirio**, and D. B. Reisenfeld, *Methane group ions in Saturn's outer magnetosphere?*, contributed talk P11B-1232 presented at Fall 2009 AGU Meeting, San Francisco, Ca, Dec. 14-18, 2009.
345. **Sittler, Jr.**, E.C., and J. F. **Cooper**, *Synergism of Saturn, Enceladus, and Titan and formation of HCNO exobiological molecules*, contributed talk presented at Titan Through Time Workshop, NASA Goddard Space Flight Center, April 6-8, 2010.

346. **Sittler, Jr.**, E.C., and J. F. **Cooper**, *Synergism of Saturn, Enceladus and Titan and Formation of HCNO exobiological molecules*, contributed talk 5029 presented at *Astrobiology Science Conference 2010: Evolution and Life: Surviving Catastrophes and Extremes on Earth and Beyond (2010)*, League City, Texas, April 26–29, 2010.
347. **Sittler, Jr.**, E. C., J.F. **Cooper**, R.E. **Hartle**, A.S. **Lipatov**, P.R. Mahaffy, W.R. **Paterson**, N.P. Paschalidis, M.A. Coplan, and T.A. Cassidy, *Plasma IMS composition measurements for Europa and the other galilean moons*, contributed talk presented at Europa Jupiter System Mission Science Workshop, Noordwijk, Netherlands, May 17-18, 2010.
348. **Sittler, Jr.**, E.C., Jr., A. Ali, J.F. **Cooper**, R.E. **Hartle** and A.J. Coates, *Prebiotic chemistry of Titan's atmosphere?: Cassini observations and future laboratory experiments and modeling*, contributed talk presented at Faraday Discussion 147 Conference, Chemistry of the Planets, Saint Jacut de la Mer, Brittany France, Poster, June 14-16, 2010.
349. **Sittler, Jr.**, E.C., J.F. **Cooper**, and R.E. **Hartle**, *Titan's interaction with Saturn's magnetosphere as viewed by T9 and T18 flybys*, contributed talk B03-0014-10 presented at 38th COSPAR Scientific Assembly, Bremen, Germany, July 18-25, 2010.
350. **Sittler, Jr.**, E.C., and J.F. **Cooper**, *Synergism of Saturn, Enceladus and Titan and formation of HCNO exobiological molecules*, contributed talk presented at Titan Surface Science Workshop, DLR, Berlin, Germany, Sept, 16-17, 2010
351. Spanswick, E. L., E. Donovan, A. Lui, L. **Kepko**, J. Liang, and W. Liu, *Comparing the evolution of solar cycles 21, 22, and 23 via a sensitive magnetic ratio*, contributed talk presented at the Fall meeting of the American Geophysical Union, San Francisco, California, December 2009
352. Spanswick, E., E. Donovan, M. Henderson, L. **Kepko**, J. Liang, R. Friedel, and A. Lui, *The relationship between plasma sheet flow, motion of auroral features, and rural brightenings*, contributed talk presented at the International Conference on Substorms-10, Pismo Beach, California, March 22-26, 2010.
353. Spence, H. E., and **T.E. Moore**, 2009 AGUFM, *Magnetospheric Constellation Revisited*, Eos Trans. Am. Geophys. Un.
354. **St Cyr**, O.C., H. **Xie**, M.L. **Mays**, J.M. **Davila**, H.R. **Gilbert**, S.I. **Jones**, **W.D. Pesnell**, **N. Gopalswamy**, **J.B. Gurman**, S. **Yashiro**, J. Wuelser, R.A. Howard, **B. J. Thompson**, and **W. T. Thompson**, *Recent STEREO observations of coronal mass ejections*, Abstract SH11A-1491, oral presentation at the Fall 2010 Meeting of the AGU, December 2009.
355. Stenborg, G.A., T. **Nieves-Chinchilla**, W. Gonzalez, and A. **Figuroa-Viñas**, *Magnetic Field Fluctuations as Possible Enhancers of Geomagnetic Storms*, poster presented at the Spring AGU-Meeting, Foz do Iguacu, Brasil, August 2010
356. **Strong**, K.T., and J.L.R. **Saba**, *A Successful Prediction of the Onset of Solar Cycle 24*, poster presented at Space Weather Workshop, Boulder, CO, April 27-30, 2010; presented with revisions at SHINE 2010, Santa Fe, N.M., July 26-30, 2010 June 2010
357. **Strong**, K.T., SDO: *Our New Eye on the Sun*, Public EPO lecture, Portsmouth, UK (INVITED), June 2010
358. **Strong**, K.T., *Growing the Space Weather Enterprise*, Space Weather Workshop, Boulder, CO, April 2010 (INVITED)
359. **Strong**, K.T., & J.L.R. Saba *Understanding and Predicting the Solar Cycle: Introduction*, SHINE, Santa Fe, NM, July 2010 (INVITED)

360. **Summerlin**, E.J. *Modeling Spectral Turnovers in Interplanetary Shocks Observed by Ulysses* contributed talk presented at Fall AGU meeting, San Francisco, California, December 2009
361. **Summerlin**, E. J. *Implementing the Second-Order Fermi Process in a Kinetic Monte-Carlo Simulation* poster as SHINE conference, Santa Fe, New Mexico, July 2010
362. **Szabo**, A., **J. Merka**, **T. Narock**, *Multispacecraft Observations of Solar Wind Gradients Near L1: VHO Case Studies*, American Geophysical Union Fall Meeting, San Francisco, 2009.
363. Taylor, P., S. Nagihara, P. Lowman, B. Milam, D. Williams, K. Zacny, Y. Nakamura, **P. Chen**, P. and K. Hills, *Lunar Heat Flow-Past and Future*, poster presented at 3rd Lunar Science Forum, NASA Ames, Moffett Field, California, July 2010
364. Taylor, P.T., P.D. Lowman, and P.C. **Chen**, *GSC-1: A lunar Simulant from a Jurassic Sill in Leesburg, Virginia*, poster presented at 3rd Lunar Science Forum, NASA Ames, Moffett Field, California, July 2010
365. **Thompson**, W.T., *Strong rotation of an erupting quiescent polar crown prominence*, contributed talk presented at AAS/SPD meeting, Miami, Florida, May 2010, and again at COSPAR general assembly, Bremen, Germany, July 2010.
366. **Thompson**, W.T., *Prominence eruptions viewed in 3D by STEREO*, contributed talk presented at Solar Image Processing Workshop V, Les Diablerets, Switzerland, September 2010.
367. Tripathi, D., H. Mason, and J.A. **Klimchuk**, *Identifying the Dominant Heating Mechanism in Active Region Core Loops*, contributed poster presented at IAU Symposium 273: Physics of Sun and Star Spots, Ventura, California, August 2010
368. Truhlik, V., R.F. **Benson**, D. **Bilitza**, J.M. Grebowsky, Y. **Wang**, *Relating OGO-5 H⁺ Plasmapause Transitions to Mid-Latitude Topside-Ionospheric Signatures*, poster presented at AGU Fall meeting, San Francisco, December 2009
369. Truhlik, V., D **Bilitza**, and L Triskova, *A new global empirical model of the electron temperature for the upper and topside ionosphere with inclusion of the solar activity variation*, INVITED talk presented at the IRI Workshop, Kagoshima, Japan, November 2009.
370. Truhlik, V., D **Bilitza**, P Richards, C Stolle, and L Triskova, *Pecularity of modeling of the electron temperature in the equatorial latitude*, contributed talk presented at the IRI Workshop, Kagoshima, Japan, November 2009.
371. Truhlik, V., Claudia Stolle, Dieter **Bilitza**, Phil Richards, and Ludmila Triskova, *Variation of the Electron Temperature in Morning Time Sector of the Equatorial Topside Ionosphere*, poster presented at EGU meeting, Vienna, Austria, May 2010.
372. Truhlik, V., L. Triskova, J. Grebowsky, D. **Bilitza**, and R. **Benson**, *Possible contribution of the OGO-5 ion composition measurements to an extension of the IRI for the plasmasphere*, poster presented at the COSPAR meeting, Bremen, Germany, July 2010.
373. **Usmanov**, A.V., M.L. **Goldstein**, *Magnetohydrodynamic modeling of the solar wind in the outer heliosphere*, UAH (University of Alabama in Huntsville) Workshop 2010, INVITED talk presented at Partially Ionized Plasmas throughout the Cosmos, Nashville, Tennessee, October 2010
374. **Usmanov**, A.V., M.L. **Goldstein**, *Global solar wind structure: Effects of pickup protons*, INVITED talk presented at 9th Annual International Astrophysical Conference: Pickup Ions Throughout the Heliosphere and Beyond, Maui, Hawaii, March 2010

375. **Usmanov**, A.V., M. L. **Goldstein**, W.H. Matthaeus, and B. Breech, *Magnetohydrodynamic modeling of the solar wind in the outer heliosphere*, contributed talk presented at AGU Fall Meeting, San Francisco, California, December 2009
376. **Viall**, N.M., H.E. Spence, A. Vourlidas, and R. Howard, *Examining Periodic Solar-Wind Density Structures in SECCHI H11*, NASA GSFC Heliophysics Directors Seminar, Greenbelt, MD, January 15, 2010.
377. **Viall**, N.M., H.E. Spence, A. Vourlidas, and R. Howard, *Examining Periodic Solar-Wind Density Structures in SECCHI H11*, Naval Research Lab, Solar Physics Branch, March 5, 2010
378. **Viall**, N.M., H.E. Spence, A. Vourlidas, and R. Howard, *Examining Periodic Solar-Wind Density Structures in SECCHI H11A*, contributed talk presented at the AAS/SPD Meeting, Miami, Florida, May 23-27, 2010.
379. **Viall**, N.M., and J.A. **Klimchuk**, *Heating of Coronal Loops: Comparing SDO light curves with nanoflare heating models*, contributed talk presented at Solar Plasma Spectroscopy: Achievements and Future Challenges, DAMPT, University of Cambridge, 13-15 September 2010.
380. Wan, Y.S. Sazykin, M.-C. H. **Fok**, N. **Buzulukova**, and R. Wolf, *Role of Pitch Angle Anisotropy in Ring Current Electrodynamics*, poster at Fall AGU meeting, San Francisco, December 2009
381. **Wang**, T., R.J. **Thomas**, J.W. **Brosius**, P.R. Young, D.M. **Rabin**, and J.M. **Davila**, *Absolute Radiometric Calibration of EUNIS, and Calibration Updates for Hinode/EIS and SOHO/CDS*, *BAAS*, **42**, 860, 2010, poster presented at AAS/SPD meeting in Miami, FL, 2010 May 23-27.
382. **Wang**, T.J., L. **Ofman**, L., and J.M. **Davila**, *Propagating Intensity Disturbances In Coronal Loops: Waves Or Flows?* Talk, AAS/SPD meeting, Miami, FL, USA, May 23-27, 2010.
383. **Wang**, T.J., L. **Ofman**, and J.M. **Davila**, *Propagating intensity disturbances in coronal loops: Waves or flows?* Talk, 38th COSPAR Scientific Assembly, in Bremen, Germany, July 18-25, 2010
384. **Wang**, T.J., R.J. **Thomas**, J.W. **Brosius**, P.R. Young, D.M. **Rabin**, and J.M. **Davila**, *Absolute radiometric calibration of EUNIS, and calibration updates for Hinode/EIS and SOHO/CDS*, poster presented at 38th COSPAR Scientific Assembly: Flows in Solar Magnetic Structures STEREO and Hinode (E24), Bremen, Germany, July 2010.
385. **Wang**, T.J., L. **Ofman**, and J.M. **Davila**, *Propagating intensity disturbances in coronal loops: waves or flows?*, contributed talk presented at 38th COSPAR Scientific Assembly: Flows in Solar Magnetic Structures STEREO and Hinode (E24), Bremen, Germany, July 2010
386. **Wang**, Y., D.G. **Sibeck**, S.A. **Boardsen**, H. Karimabadi, T.B. Sipes, and J. **Merka**, *3D Magnetopause Modeling Based on Multi-Spacecraft Observations and Support Vector Regression Machine*, contributed talk presented at 2010 GEM Summer Workshop, Snowmass, Colorado, June 2010.
387. **Wendel**, D.E. and P. H. Reiff, *Measuring Magnetopause Reconnection Impact Parameters Using Multiple Spacecraft Measurements*, presentation at GSFC SED Director's Seminar, Heliophysics Science Division, GSFC, October, 2009.
388. **Wendel**, D.E., M.L. **Goldstein**, and P.H. Reiff, *Impact of Magnetic Draping, Convection, and Field Line-Tying on Magnetopause Reconnection Under Northward IMF*, presentation to Cluster PEACE team meeting, Mullard Space Sciences Laboratory, Dorking, UK, March 2010.
389. **Wendel**, D.E., M.L. **Goldstein**, and P.H. Reiff, *Impact of Magnetic Draping, Convection, and Field Line-Tying on Magnetopause Reconnection Under Northward IMF*, poster at AGU Meeting of the Americas, Foz de Iguacu, Brazil, August 2010.

390. **Wendel**, D.E., M.L. **Goldstein**, and A. **Figuroa-Vinas**, *Searching for Turbulent Spectra in Multiple Spacecraft Observations*, poster at AGU Meeting of the Americas, Foz de Iguacu, Brazil, August 2010
391. **Williams**, P.E. and W.D. **Pesnell**, *Comparisons of photospheric convection cell characteristics during the solar minima of cycles 22--23 and 23--24*, Abstract 317.02, poster presented at the 215th Meeting of the American Astronomical Society, January 2010.
392. **Williams**, P.E., *Supergranulation Convection at Solar Minimum* Physics Department Seminar, University of Delaware, Newark, Delaware, September 28, 2010.
393. **Wilson III**, L. B., C. A. Cattell, P. J. Kellogg, K. Goetz, K. Kersten, J. C. Kasper, A. **Szabo**, and M. Wilber, *Atypical particle heating at a supercritical interplanetary shock*, talk presented at University of California at Berkeley, October 2010. [FY2011]
394. **Yashiro**, S., *Coronal Mass Ejections and Space Weather*, INVITED talk presented at WCU (World Class University) International Workshop, Soeul, South Korea, April 2010
395. **Yashiro**, S., N. **Gopalswamy**, S. **Akiyama**, and S. Kahler, *X-ray Flare Durations and CME Associations* poster presented at SHINE Meeting, Santa Fe, New Mexico, July 2010
396. **Yokoyama**, T., and D. L. Hysell, *Numerical study of latitudinal dependence and propagation of nighttime medium-scale traveling ionospheric disturbances*, poster and contributed talk presented at 2009 AGU Fall Meeting, San Francisco, CA, December 2009
397. **Yokoyama**, T., R. F. **Pfaff**, D. L. Hysell, and M. Yamamoto, *Numerical study of nighttime MSTIDs and possible link to post-midnight irregularities observed by C/NOFS and VHF radars*, oral and contributed talk presented at C/NOFS Science Workshop, Breckenridge, CO, May 2010
398. **Yokoyama**, T., R.F. **Pfaff**, D.L. Hysell, and M. Yamamoto, *Numerical study of nighttime MSTIDs and possible link to post-midnight irregularities observed by C/NOFS and VHF radars*, 2010 CEDAR Workshop, Boulder, CO, June 2010
399. **Yokoyama**, T., and D.L.Hysell, *Numerical study of latitudinal dependence and propagation of nighttime medium-scale traveling ionospheric disturbances*, Committee on Space Research 38th COSPAR Scientific Assembly, Bremen, Germany, July 2010
400. **Zenitani**, S., *Two-fluid simulations of relativistic magnetic reconnection in pair plasmas*, 2009 US - Japan Workshop on Reconnection (MR2009), Madison, Wisconsin, October 2009 (INVITED)
401. **Zenitani**, S., *Relativistic two-fluid simulations of guide field magnetic reconnection*, AGU fall meeting, San Francisco, California, December 2009
402. **Zenitani**, S., *Two-fluid Simulations of Relativistic Magnetic Reconnection in Pair Plasmas*, 215th AAS meeting, Washington DC, January 2010
403. **Zenitani**, S. *Two-Fluid Simulations of Relativistic Magnetic Reconnection in Electron-Positron Plasmas*, Yosemite Workshop on Magnetic Reconnection, Yosemite, California, February 2010 (INVITED)
404. **Zenitani**, S., *Resistive Magnetohydrodynamic Simulations of Relativistic Magnetic Reconnection*, International Cambridge Workshop on Magnetic Reconnection, St. Andrews, Scotland, August 2010 (INVITED)
405. **Zheng**, Q., M.C. H. **Fok**, J. **Albert**, N. Meredith, R. Horne, *Pitch angle and energy cross diffusion effects on the electron fluxes in the outer belt*, University of Michigan, Ann Arbor, MI, Feb 2010.
406. **Zheng**, Q., M.-C. H. **Fok**, J. **Albert**, N. Meredith, R. Horne, *Effect of pitch angle and energy cross diffusion on radiation belt electrons*, GEM meeting, Snowmass, CO, 2000

Conferences Attended

In chronological order:

1. 41st Annual Meeting of the Division for Planetary Sciences [DPS] of the American Astronomical Society [AAS], Fajardo, Puerto Rico, 4-9 Oct. 2009
2. IEEE [Institute of Electrical and Electronics Engineers] Nuclear Science Symposium and Medical Imaging Conference, Orlando, Florida, 25 Oct. 2009
3. International Conference on Space Science and Communication, Port Dickson, Negeri Sembilan, Malaysia, 26-27 Oct. 2009
4. STEREO Science Working Group meeting, Meredith, New Hampshire, 26-30 October 2009
5. ERG [Energization and Radiation in Geospace], SCOPE [cross-Scale Coupling in Plasma universe], and Beyond, ISAS/JAXA, Sagimura, Japan, 2-5 Nov. 2009
6. Solaire Workshop, St. Andrews, Scotland, 2-6 Nov. 2010 [Solaire is a research training network financed by the European Commission.]
7. IRI [International Reference Ionosphere] Workshop, Kagoshima, Japan, 2-7 Nov. 2009
8. 19th MESSENGER Science Team Meeting, Columbia, Maryland, 5-7 Nov. 2009
9. American Society of Information Science and Technology Annual Meeting, Vancouver, British Columbia, 6-11 Nov. 2009
10. CPS [Centre for Planetary Sciences] Workshop on Icy Moons and Origin of Jupiter and Other Giant Planets, Hokkaido University, Sapporo, Japan, 9-10 Nov. 2009
11. LWS [Living With a Star] CDAW [Coordinated Data Analysis Workshop] on Ground level enhancement events, University of Alabama, Huntsville, Alabama, 16-18 Nov. 2009
12. Solar Wind-Space Environment Interaction (IAGA-2) [IAGA = International Association of Geomagnetism and Aeronomy] meeting, Cairo, Egypt, 4-8 Dec. 2009
13. GEM [Geospace Environment Modeling] Mini-Workshop, San Francisco, California, 13 Dec. 2009
14. AGU [American Geophysical Union] Fall Meeting, San Francisco, California, 14-18 Dec. 2009.
15. 215th AAS Meeting, Washington, DC, 3-7 Jan. 2010
16. USNC-URSI [United States National Committee for the International Union of Radio Science] National Radio Science Meeting, Boulder, Colorado, 5-8 Jan. 2010
17. 2010 USNC-URSI National Radio Science Meeting in Boulder, Colorado, 6-9 Jan. 2010
18. 90th Annual American Meteorological Society [AMS] Meeting, Atlanta, Georgia, 17-21 Jan. 2010
19. CCMC [Community Coordinated Modeling Center] Workshop, Key Largo, Florida, 25-29 Jan. 2010
20. Lunar Dust, Plasma & Atmosphere: The Next Steps, Boulder, Colorado, 27-29 Jan. 2010
21. TWINS Science Team Meeting, SWRI, San-Antonio, Texas, 3-5 Feb. 2010
22. SDO [Solar Dynamics Observatory] Science Working Group Meeting, Titusville, Florida, 6 Feb. 2010
23. Yosemite Reconnection Workshop, Yosemite, California, 9-12 Feb. 2010

24. 16th National Space Science Symposium, Rajkot, India, 24-27 Feb. 2010
25. Joint Voyager-IBEX Meeting, San Antonio, Texas, 9-11 Mar. 2010
26. 9th Annual International Astrophysics Conference “Pickup Ions Throughout the Heliosphere and Beyond”, Maui, Hawaii, 14-19 Mar. 2010
27. International Conference on Substorms-10, Pismo Beach, California, 22-26 Mar. 2010
28. STEREO Science Working Group #21, Trinity College, Dublin, Ireland, 24-26 Mar. 2010
29. ISSI [International Space Science Institute] team meeting: Solar Prominence Formation and Equilibrium: New Data, New Models; Bern, Switzerland, 29 Mar -- 2 Apr. 2010
30. Titan Through Time Workshop, NASA's Goddard Space Flight Center, Greenbelt, Maryland, 6-8 Apr. 2010
31. Research Data Access and Preservation Summit, Phoenix, Arizona, 9-10 Apr. 2010
32. Dynamical Processes in Space Plasmas, Israel, 10-17 Apr. 2010
33. RHESSI 10th Science Workshop, Annapolis, Maryland, 1-5 Aug. 2010
34. 7th Annual CubeSat Developers' Workshop, Cal Poly, San Luis Obispo, 21-23 Apr. 2010.
35. Astrobiology Science Conference 2010: *Evolution and Life: Surviving Catastrophes and Extremes on Earth and Beyond*, League City, Texas, 26-29 Apr. 2010.
36. Space Weather Workshop, Boulder, Colorado, 27-30 Apr. 2010
37. European Geophysical Union General Assembly 2010, Vienna, Austria, 2-7 May 2010.
38. Europa Jupiter System Mission Science Workshop, Nordwijk, Netherlands, 17-18 May 2010
39. C/NOFS Science Meeting, Breckenridge, Colorado, 18-20 May 2010
40. 216th Meeting of the AAS, Miami, Florida, 23-27 May 2010
41. AAS Solar Physics Division Meeting, Miami, Florida, 23-27 May 2010
42. 20th Slovakian Solar Seminar, Podjavornik, Slovakia, 31 May – 4 Jun. 2010
43. ACE/SOHO/STEREO/WIND Workshop, Kennebunkport, Maine, 8-11 Jun. 2010
44. 20th MESSENGER Science Team Meeting, Boston, Ma, USA, 8-10 Jun. 2010
45. BUKS [Belgium, U.K., Spain] 2010 Meeting at St Andrews University, 9-11 Jun. 2010
46. Faraday Discussion 147: *Chemistry of the Planets*; Saint Jacut de la Mer, Brittany, France, 14-16 Jun. 2010.
47. NSF Geospace Environment Modeling Meeting, Snowmass, Colorado, 20-25 Jun. 2010
48. CEDAR Coupling, Energetics, and Dynamics of Atmospheric Regions? Workshop, Boulder, Colorado, 20-25 Jun. 2010
49. 2010 Western Pacific Geophysics Meeting, Taipei, Taiwan, 22-25 Jun. 2010
50. SPIE meeting, San Diego, California, 27 Jun. – 1 Jul. 2010
51. GONG 2010 – SoHO 24 conference in Aix-en-Provence, France, 27 Jun. – 2 Jul. 2010
52. Asia Oceania Geosciences Society meeting, Hyderabad, India, 5-9 Jul. 2010
53. 12th Solar Terrestrial Physics Symposium, Berlin, Germany, 12-16 Jul. 2010

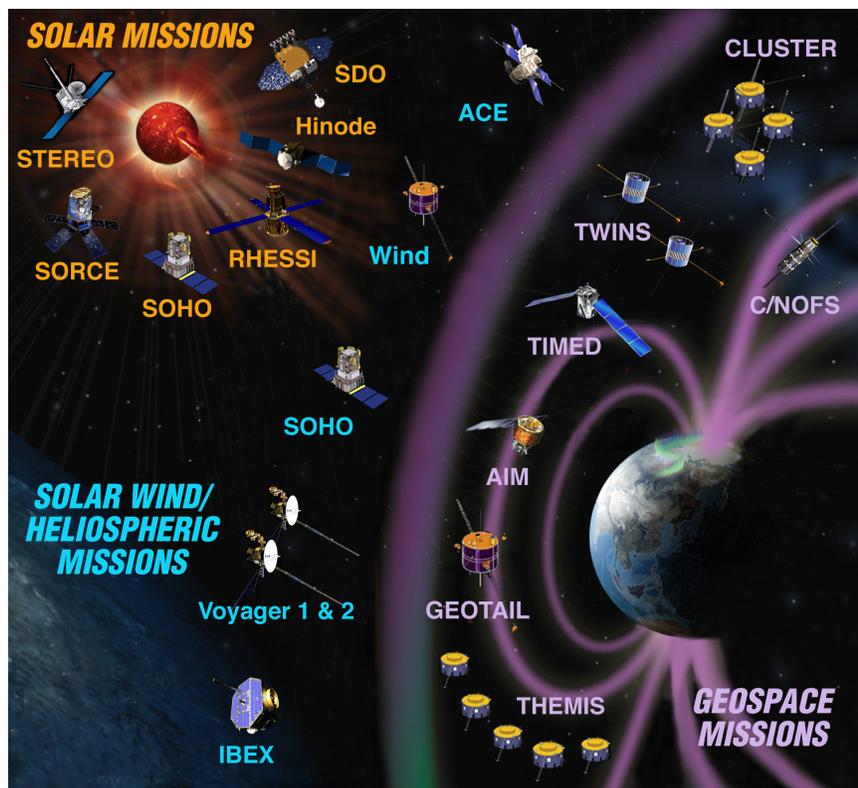
54. 38th COSPAR Scientific Assembly, Bremen, Germany, 18-25 Jul. 2010
55. 3rd Lunar Science Forum, NASA Ames, Moffett Field, California, 20-22 Jul. 2010
56. SHINE [Solar, Heliospheric, & INterplanetary Environment], Santa Fe, New Mexico, 26-30 Jul. 2010
57. International Society for Technology in Education Conference, Denver, Colorado, 27-30 Jun. 2010
58. Astronomical Society of the Pacific Annual Meeting, Boulder, Colorado, 31 Jul.– 4 Aug. 2010
59. 10th RHESSEI workshop, Annapolis, Maryland, 1-6 Aug. 2010
60. Meeting of the Americas, Foz do Iguassu, Brazil, 8-12 Aug. 2010
61. TWINS Science Team Meeting, JHU APL, Laurel, Maryland, 16-18 Aug. 2010
62. Advanced Computational Capabilities for Exploration in Heliophysical Science, Boulder, Colorado, 16-18 Aug. 2010
63. LWS Focused Science Team meeting, Boulder, Colorado, 18-19 Aug. 2010
64. IAU [International Astronomical Union] Symposium 273: Physics of Sun and Star Spots, Ventura, California, 22-26 Aug. 2010
65. 10th Hvar Astrophysics Colloquium: The Active Sun, Hvar, Croatia, 6-10 Sep. 2010
66. 5th Solar Image Processing Workshop (SIPWork V), Les Diablerets, Switzerland, 12-16 Sep. 2010
67. Solar Plasma Spectroscopy: Achievements and Future Challenges, Celebrating the Career of Dr Helen Mason, DAMTP, University of Cambridge, Cambridge, UK, 13-15 Sep. 201
68. Annual Meeting of the Lunar Exploration Analysis Group (LEAG 2010), Washington, DC, 14-16 Sep. 2010
69. 7th International Workshop on Planetary, Solar, and Heliospheric Radio Emissions (PRE VII), Graz, Vienna, 15-17 Sep. 2010
70. Titan Surface Science Workshop, DLR, Berlin, Germany, 16-17 Sep. 2010.
71. SDO [Solar Dynamics Observatory] data in Europe Meeting, Royal Observatory of Belgium, Brussels, Belgium, 17 Sep. 2010
72. European Planetary Science Congress 2010, Rome, Italy, 19-24 Sep. 2010
73. LWS CDAW, San Diego, California, 21-24 Sep. 2010
74. LWS CDAW on CME flux ropes, San Diego, California, 22-25 Sep. 2010
75. Cluster 10th Anniversary workshop, Corfu, Greece, 27 Sep. – 1 Oct., 2010

APPENDIX C: Current Missions

Project Leadership

Heliophysics covers a vast volume of space from the center of the Sun to the edge of interstellar space. HSD looks at diverse physical processes from magnetic reconnection to particle acceleration, shock formation to convection, and thermal conduction to nonthermal heating. This requires the use of many different observing techniques, both remote and in situ, from a variety of vantage points. In recent years, it has become apparent that little further progress will be made unless these phenomena are studied as a “system of systems.”

A fleet of spacecraft, referred to in NASA Headquarters parlance as the Heliophysics Great Observatory (HGO), is currently being flown. Each mission is addressing its own aspect of the problems that HSD is trying to unravel. HSD is the nexus of these projects, having a management role in all but three of these missions and scientific participation in all of them (see the table below).



The HGO: Currently, heliophysics has three missions observing the ionosphere, mesosphere, and thermosphere regions; four missions observing the magnetosphere; six missions sampling the solar wind and heliosphere; and six missions observing the Sun. These make up a powerful combination of in situ and remote-sensing instruments.

Heliophysics Flight Missions			
Mission	Launch Date	Project/Mission Scientist	Scientific Studies of:
SDO	2010 Feb 11	Dean Pesnell (GSFC)	Solar dynamo, solar activity
IBEX	2008 Oct 19	Bob MacDowall (GSFC)	Outer heliosphere
C/NOFS	2008-Apr-16	Rob Pfaff (GSFC)	Ionospheric scintillations
AIM	2007-Apr-02	Hans Mayr (GSFC)	Mesospheric clouds
THEMIS	2007-Feb-17	Dave Sibeck (GSFC)	Substorms
STEREO	2006-Oct-25	Joe Gurman (GSFC)	CMEs
Hinode	2006-Sep-22	John Davis (MSFC)	Solar magnetic fields
SORCE	2003-Jan-25	Robert Callahan (GSFC)	Solar irradiance
RHESSI	2002-Feb-05	Brian Dennis (GSFC)	High-energy flares
TIMED	2001-Dec-07	Dick Goldberg (GSFC)	Thermosphere, ionosphere, mesosphere
Cluster	2000-Jul-16 2000-Aug-09	Mel Goldstein (GSFC)	Particle / magnetic field interactions
TWINS	2000-Mar-25	Mei-Ching Fok (GSFC)	Magnetosphere
TRACE	1998-Apr-01	Joe Gurman (GSFC)	Solar atmosphere
ACE	1997-Aug-25	Tycho von Rosenvinge (GSFC)	Solar wind
SOHO	1995-Dec-02	Joe Gurman (GSFC)	Solar interior, magnetic activity cycle, corona, solar wind
Wind	1994-Nov-01	Adam Szabo (GSFC)	Solar wind
Geotail	1992-Jul-24	Guan Le (GSFC)	Dynamics of the magnetotail
Voyager 1 Voyager 2	1977-Sep-05 1977-Aug-20	Ed Stone (JPL)	Heliosphere
Heliophysics Programs			
Solar Terrestrial Probes		Jim Slavin (GSFC)	
Living With a Star		Chris St. Cyr (GSFC)	

Appendix C briefly outlines (in reverse chronological order) the purpose and status of each of the current heliophysics missions and GSFC’s role in them.

Heliophysics missions consist of an extensive network of space observatories that monitor the Sun’s variability and its effects on the entire solar system, life, and society. In FY2010, HSD was responsible for 18 missions, either in their entirety or in part. In this appendix, we summarize the history, scientific objectives, GSFC role, and the current status of each mission.

Solar Dynamics Observatory (SDO)

SDO is the first LWS mission. It uses a battery of telescopes to study the Sun's magnetic field, the interior of the Sun, and changes in solar activity. Some of the telescopes will take pictures of the Sun, while others will view the Sun as a star.

The primary goal of the SDO mission is to understand—driving towards a predictive capability—the solar variations that influence life on Earth and humanity's technological systems by determining:

- How the Sun's magnetic field is generated and structured
- How this stored magnetic energy is converted and released into the heliosphere and geospace in the form of solar wind, energetic particles, and variations in the solar irradiance

GSFC built the spacecraft, and designed and built the dedicated ground system. Dean Pesnell (HSD) is the Project Scientist, and Barbara Thompson and Phil Chamberlin are Deputy Project Scientists. Several HSD people are part of the science investigation and help with E/PO. SDO is managed by GSFC during Phase E.

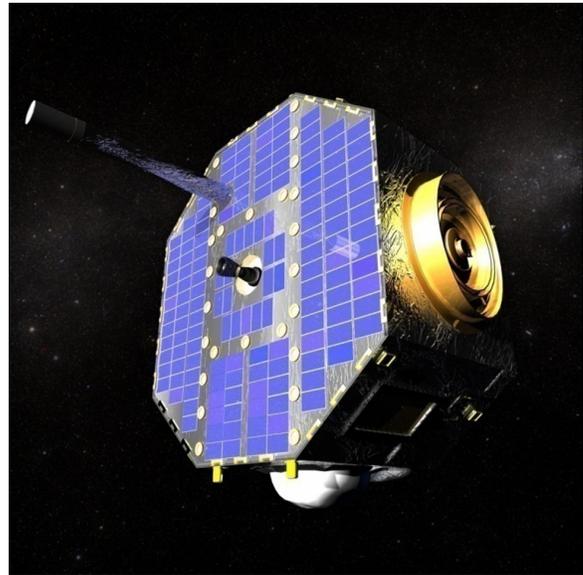
SDO was launched atop an Atlas V/Centaur launch vehicle on 2010 February 11. During the launch several atmospheric phenomena were observed, including a wave that rippled across the sky as SDO passed through a layer of ice particles. SDO entered Phase E on 2010 May 1 and has since been returning excellent science data. A First Light Press Conference was held at the Newseum in Washington, DC. Images from this press conference are still being seen in articles. Watching the Sun in its current minimum state has produced a plethora of filament eruptions and case studies for global (or lack of global) response to the small flares that have occurred in 2010. First science results from SDO were presented at the fall 2010 Meeting of the AGU.



A prominence eruption on 2010 March 30 taken in He II (304Å) shows twisting motions of the material is the most noticeable feature. VIDEO

Interstellar Boundary Explorer (IBEX)

The solar system moves through a part of the galaxy referred to as the local interstellar medium (LISM). It is built up from material released from the stars of the Milky Way galaxy through stellar winds, novae, and supernovas. The interstellar medium has considerable structure, and the region where the solar wind interacts with the LISM is very complex. IBEX uses two ENA detectors to map out this interaction region at several energies. These sensors also detect interstellar neutrals that flow into the solar system. The figure below shows the first direct measurements of LISM hydrogen and oxygen. IBEX images reveal global properties of the interstellar boundaries that separate the heliosphere from the LISM. Because IBEX provides global maps of the interstellar interaction, IBEX observations are highly complementary to, and synergistic with, the detailed single-direction measurements provided by the Voyager satellites.

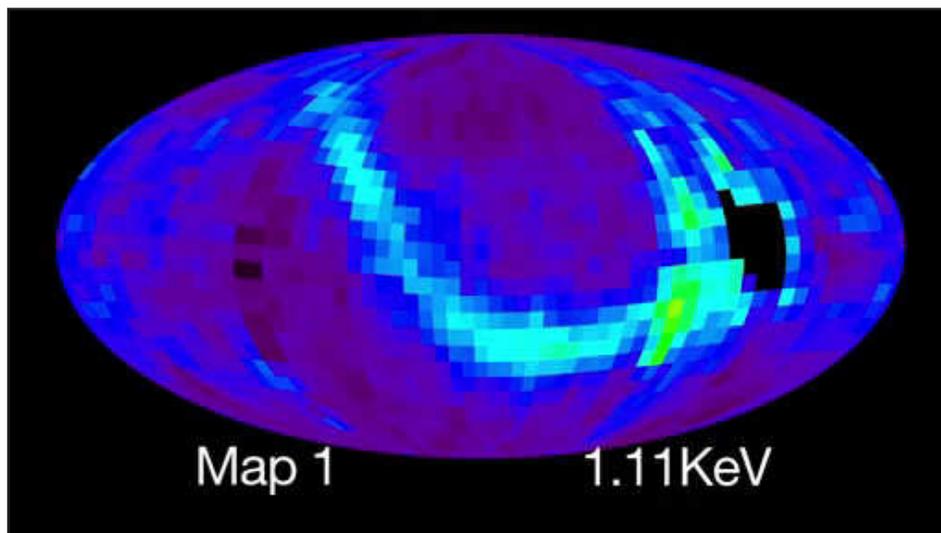


IBEX's sole science objective is to discover the global interaction between the solar wind and the interstellar medium. IBEX achieves this objective by taking a set of global ENA images that answer four fundamental science questions:

- What is the global strength and structure of the termination shock?
- How are energetic protons accelerated at the termination shock?
- What are the global properties of the solar wind flow beyond the termination shock and in the heliotail?
- How does the interstellar flow interact with the heliosphere beyond the heliopause?

An HSD scientist is a Co-I on IBEX, and the Deputy Mission Scientist is also in HSD.

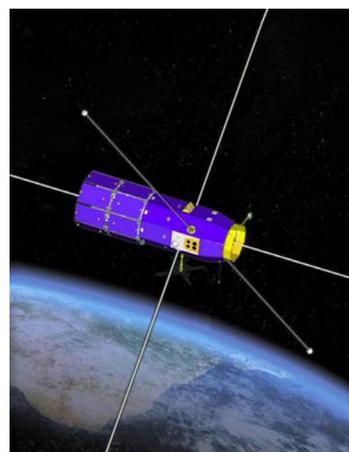
IBEX is executing its prime mission and has finished collecting its third all-sky map.



Comparison of the 3 all-sky maps so far completed by IBEX

Communications/Navigation Outage Forecasting System (C/NOFS)

The C/NOFS mission includes a satellite designed to investigate and forecast scintillations in the Earth's ionosphere. C/NOFS was launched on a Pegasus-XL rocket on 2008 April 17 into LEO configuration with an inclination of 13°, a perigee of 400 km, and an apogee of 850 km. The satellite, which is operated by the USAF Space Test Program, will allow the U.S. military to predict the effects of ionospheric activity on signals from communication and navigation satellites, outages of which could potentially cause problems in battlefield situations. C/NOFS makes comprehensive measurements of vector DC and wave electric fields, magnetic fields, plasma density and temperature, ion drifts, neutral winds, and lightning detector counts, and includes GPS scintillation and radio beacon experiments. Combined with strong modeling and ground-based observing components, this mission promises to demonstrably advance scientific understanding of ESF irregularities and their conditions for growth.



C/NOFS Spacecraft

The Coupled Ion Neutral Dynamic Investigation (CINDI) is a Mission of Opportunity investigation on C/NOFS sponsored by NASA, and designed and built by the University of Texas at Dallas. CINDI involves two instruments that measure the concentration and kinetic energy of the ions and neutral particles in space as the satellite passes through them. This information will be used in building models to understand the various structures in the ionosphere, such as plasma depletions and associated turbulence in the nightside, low-latitude ionosphere. These structures can interfere with radio signals between Earth and spacecraft in orbit, thus causing errors in tracking and loss of communication. HSD built the C/NOFS Vector Electric Field Instrument (VEFI), which consists primarily of an electric field detector that utilizes three orthogonal 20-m tip-to-tip double-probe antennas. VEFI measures DC electric fields, which cause the bulk plasma motion that drives the ionospheric plasma to be unstable. Additionally, it measures the quasi-DC electric fields within plasma density depletions to reveal the motions of the depletions relative to the background ionosphere. VEFI also measures the vector AC electric field, which characterizes the ionospheric disturbances associated with spread-F irregularities. An FGM, an optical lightning detector, and a fixed-bias Langmuir probe are also included in VEFI. HSD also manages the MO&DA funding for CINDI, and provides the NASA Project Scientist support.

C/NOFS continues to perform well and return unprecedented measurements of the low-latitude ionosphere. The recent extreme solar minimum has manifested itself in a lack of enhanced electric fields at sunset, which are generally associated with ionospheric spread-F, which, in turn, is the source of intense irregularities and turbulence. On the other hand, C/NOFS probes have shown a surprising preponderance of plasma density depletions near dawn, with electric field turbulence observed throughout the nightside. In addition, significant tide-driven electric field and density variations are routinely observed on almost every orbit, revealing that such processes are a common feature of the Earth's ionosphere.

Aeronomy of Ice in the Mesosphere (AIM)

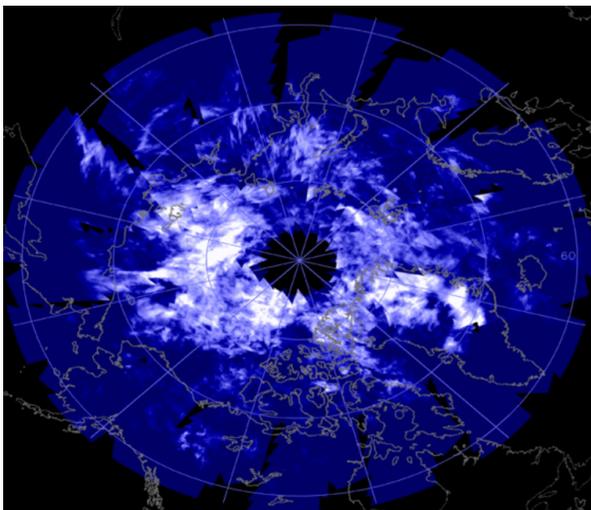
The AIM spacecraft was launched from a Pegasus rocket on 2007 April 25 into a 600-km orbit. It has already observed four Northern Hemisphere seasons and three Southern Hemisphere seasons. AIM is the first satellite mission dedicated to the study of polar mesospheric clouds (PMCs), also known as noctilucent clouds, and it makes measurements that can provide information on how these clouds form and vary. AIM addresses the following questions:

- Are there temporal variations in PMCs that can be explained by changes in solar irradiance and particle input?
- What changes in mesospheric properties are responsible for north/south differences in PMC features?
- What controls interannual variability in PMC season duration and latitudinal extent?
- What is the mechanism of teleconnection between winter temperatures and summer hemisphere PMCs?
- What is the global occurrence rate of gravity waves outside the PMC domain?



A striking ISS astronaut photograph shows polar mesospheric clouds over the Southern Hemisphere on 2010 January 30

Despite a significant increase in PMC research in recent years, relatively little is known about the basic physics governing these clouds at “the edge of space,” and why they are changing. They have increased in brightness over time, are being seen more often, and appear to be occurring at lower latitudes than ever before. It has been suggested (and debated) that these changes are linked to global climate change.



AIM image of PMCs over the Northern Hemisphere on 2009 July 14. The PMCs were observed as far south as Paris, France on this day.

Dr. Jackman is the Project Scientist, HSD’s Dr. Sigwarth is the deputy Project Scientist, and Mr. Cuevas is the Mission Director of the AIM mission. Significant discoveries for FY2010 are:

On a near global scale, the PMC season turns on and off abruptly like a geophysical light bulb, going from zero to 100% frequency of occurrence in days

PMCs are highly variable from orbit-to-orbit and can be destroyed or created in less than 2 hours

Large scale planetary waves in the Earth’s upper atmosphere cause PMCs to vary globally, while smaller scale gravity waves cause the clouds to disappear regionally

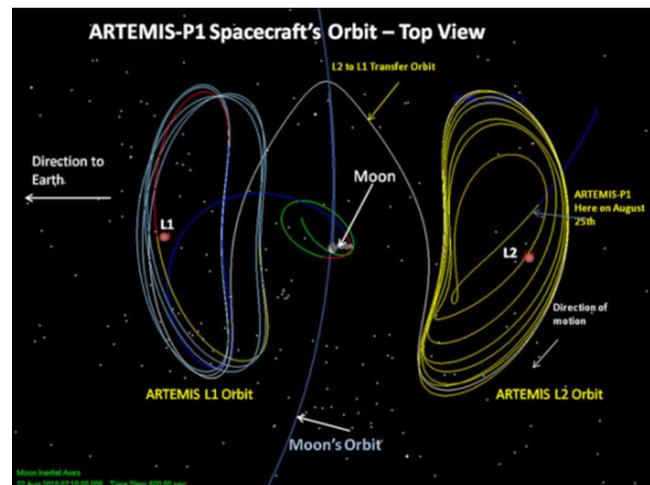
AIM was selected through the Senior Review process to continue its mission through FY2014.

Time History of Events and Macroscale Interactions during Substorms (THEMIS)

With three spacecraft covering the magnetopause and inner magnetosphere (THEMIS), two spacecraft orbiting the Moon (ARTEMIS), along with a network of ground observatories tracking geomagnetic perturbations and auroral signatures night after night, THEMIS and ARTEMIS currently serve as the cornerstone of the HGO, enabling researchers to understand both the magnetospheric and lunar responses to ever-varying solar wind conditions. The primary objective of THEMIS was to determine the cause of geomagnetic substorms. The mission employed five identical spacecraft and an array of ground-based all-sky imagers and magnetometers

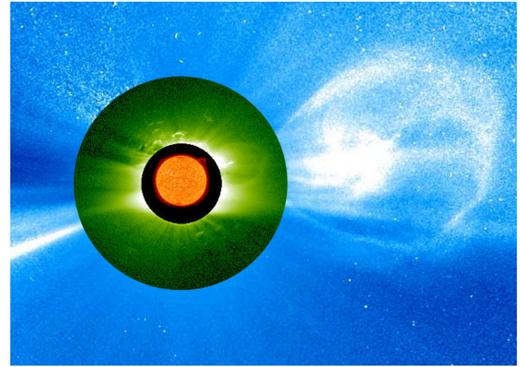
to pinpoint when and where substorm onset occurs in the magnetotail. With the primary objective completed, THEMIS has now turned to its secondary and tertiary objectives of understanding the inner magnetospheric response to substorm injections, understanding the processes that accelerate thermal plasmas to form the ring current and radiation belts, and obtaining a detailed understanding of the solar wind-magnetosphere interaction via simultaneous measurements of the solar wind, foreshock, magnetosheath, and magnetopause. The two outermost probes have been relocated to the Moon for the ARTEMIS mission, where they will study distant tail magnetic reconnection, solar wind turbulence, and the electrodynamics of the Moon's interaction with the Sun, while also providing near-Earth measurements of the solar wind. HSD provides the Project Scientist and participates in scientific analysis.

The outermost two spacecraft have been relocated to the Moon, where they are currently orbiting in Lissajous orbits around Lunar Lagrange points L1 and L2 – the first time spacecraft have orbited there – and will enter permanent lunar orbits next spring. During these Lissajous orbits the probes will provide two point measurements of the solar wind, lunar wake, and distant magnetotail. THEMIS science highlights include a GRL paper demonstrating that plasma flows emanating from reconnection sites strike the inner magnetosphere leading to global magnetic field oscillations; press conference at the 2009 Fall AGU on “Colliding Auroras,” demonstrating fast moving auroral features impacting the stable equatorward boundary, leading to substorm onset; and a Science paper linking pulsating auroral patches with magnetospheric observations for the first time. All instruments and spacecraft are fully operational; the same is true for the ground observatories. Although a portion of the ARTEMIS probe P1 electric field instrument was recently damaged by a suspected micrometeoroid impact, we expect to be able to recover full science from this instrument. While ARTEMIS orbits the Moon, the remaining three innermost spacecraft are continuing the core THEMIS mission, with orbits optimized to study magnetopause reconnection, radiation belt physics, and magnetospheric current systems. Existing datasets are widely disseminated and easily available; this will continue for forthcoming datasets, including ARTEMIS data.



Solar Terrestrial Relations Observatory (STEREO)

The twin STEREO spacecraft – Ahead (A) and Behind (B) – were launched on 2006 October 26 from Kennedy Space Center aboard a Delta 7925 launch vehicle. Each spacecraft used close flybys of the Moon to escape into orbits about the Sun near 1 AU; one spacecraft (A) now leads Earth, while the other (B) trails. Relative to the Earth-Sun line, the two spacecraft separate at about 44o per year, so at the end of FY2010 they were separated by 159o. Each STEREO spacecraft is equipped with an almost identical set of optical, radio, and in situ particle and field instruments provided by United States and European investigators. The purposes of the STEREO mission are to:



A coronal mass ejection (CME) observed by STEREO on 2008 December 12

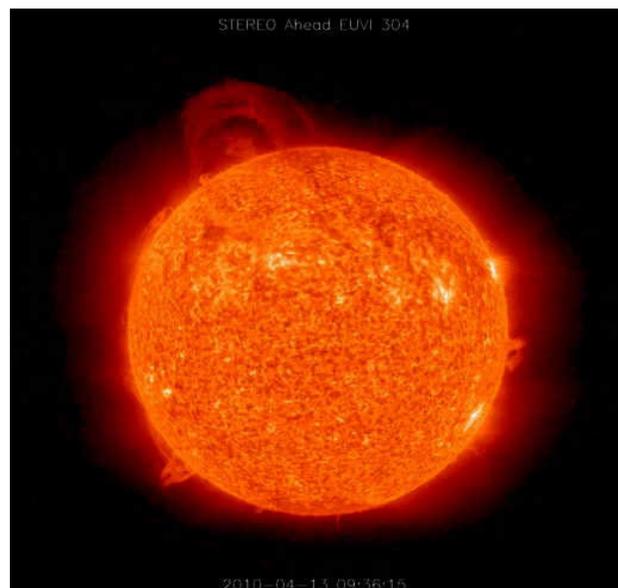
- Understand the causes and mechanisms of CME initiation
- Characterize the CME propagation through the inner heliosphere to Earth
- Discover the mechanisms and sites of energetic-particle acceleration in the low corona and the interplanetary medium
- Develop a 3D time-dependent model of the magnetic field topology, temperature, density, and velocity structure of the ambient solar wind

GSFC, with Swales Aerospace, provided the inner coronagraph, COR1, for the STEREO Sun–Earth Connection Coronal and Heliospheric Investigation (SECCHI). The HSD manages the mission, through the office of the Project Scientist’s and the STEREO Science Center. The Science Center is the focal point for STEREO science coordination as well as for E/PO; it processes the space-weather-beacon data, and archives STEREO telemetry, mission support data, higher-level instrument data, and analysis software. HSD science team members provide software for SECCHI and engage in science analysis.

Significant project milestones achieved in FY2010 are:

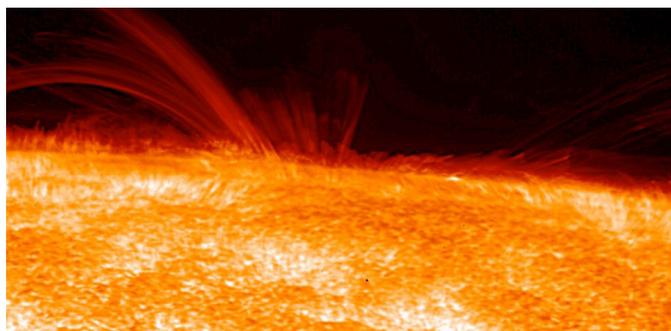
- Successful End of Prime Mission review (2009 November)
- Second mission extension (3 years) granted by the Senior Review, 2010 July

STEREO-A caught an eruptive prominence as it blasted away from the Sun on 2010 April 12-13.



Hinode

Hinode is a mission of the Japan Aerospace Exploration Agency (JAXA) with US, UK, ESA, and Norwegian collaboration. It was launched on an M-V rocket from Uchinoura Space Center, Japan, on 2006 September 22. The satellite was maneuvered to the quasi-circular Sun-synchronous orbit over the day/night terminator, which allows near-continuous observation of the Sun. Hinode was planned as a three-year mission to explore the magnetic fields of the Sun. It consists of a coordinated set of optical, extreme ultraviolet (EUV), and X-ray instruments (the Solar Optical Telescope, the EUV Imaging Spectrometer, and the X-ray Telescope) to investigate the interaction between the Sun's magnetic field and its corona. Each of the instruments has the highest angular resolution ever achieved in a solar instrument for its spectral band.



This Hinode image reveals the fine scale structure in the chromosphere that extends outward above the top of the convection cells, or granulation, of the photosphere. The structure results from the interaction of hot ionized gas with the magnetic field.

Hinode investigates the interaction between the Sun's magnetic field and the corona. The result will be an improved understanding of the mechanisms that power the solar atmosphere and drive solar eruptions. This information will explain how the Sun generates magnetic disturbances and high-energy particle storms that propagate from the Sun to Earth and beyond; in this sense, Hinode will help scientists predict space weather. It is using its three instruments together to unravel basic information to understand:

- How energy generated by magnetic-field changes in the lower solar atmosphere (photosphere) is transmitted to the upper solar atmosphere (corona)
- How that energy influences the dynamics and structure of the upper atmosphere
- How energy transfer and atmospheric dynamics affect interplanetary space

Three members of the Hinode operations team are based at GSFC and several HSD scientists are involved in the analysis of Hinode data. Sten Odenwald and Ravi Grant perform Hinode E/PO activities at GSFC. The SDAC/VSO at GSFC serves Hinode data to the solar community. The Hinode project is managed by MSFC.

Solar Radiation and Climate Experiment (SORCE)

To continue to monitor the Sun's radiative energy output and to better understand radiative forcing of the Earth's climate, NASA launched the SORCE satellite on 2003 January 25. The satellite flies at an altitude of 640 km in a 40° inclination orbit. SORCE carries four instruments that have greatly improved the accuracy and precision of the measurements of solar total and spectral irradiance. All instruments acquire data during each of the satellite's 15 daily orbits, producing data products on timescales as short as 5 minutes, but more commonly 1-4 per day. The PI (T. Woods) and mission control are located at the University of Colorado Laboratory for Atmospheric and Space Physics. SORCE's scientific goals are to answer the questions:



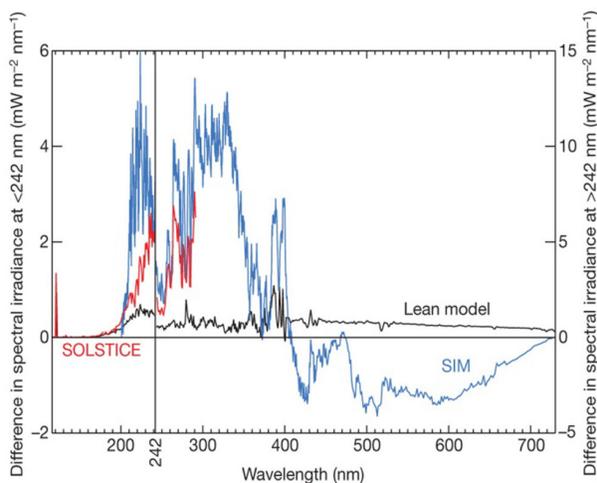
The SORCE satellite.

- What is the absolute value of the Sun's total irradiance (TSI)?
- How does the Sun's spectral irradiance vary, and what are the impacts on terrestrial climate?
- What aspects of solar variability influence the Earth's atmosphere and how?

GSFC's role includes providing the Project Scientist, R. Cahalan (Code 613.2), and Deputy Project Scientist, D. Rabin (HSD), and data archiving (GSFC Earth Science Data and Information Center)

Significant Project events in FY2010:

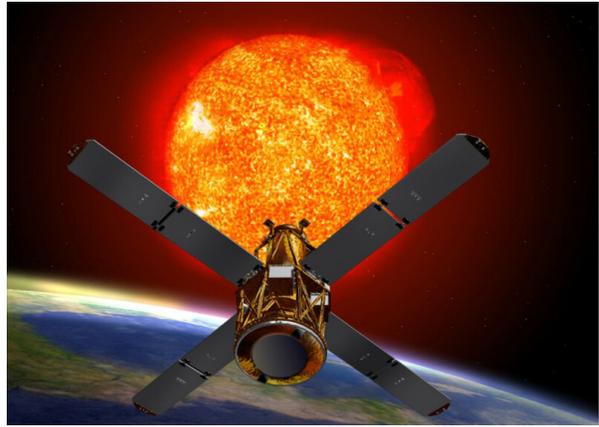
- As a result of the Senior Review process, SORCE was approved for extended mission operations during 2010–2013.
- The Mission Operations Team successfully recovered SORCE after it entered a safe hold on September 29, caused by a reset of the on-board computer. All SORCE instruments are now back on and collecting data.



The difference (2004–2007) in solar spectral irradiance ($\text{Wm}^{-2}\text{nm}^{-1}$) derived from SIM data (in blue), SOLSTICE data (in red), and the Lean model (in black). Different scales are used for values at wavelengths below and above 242nm. Researchers fed these data into the Imperial College computer model and compared their results with earlier estimates of solar cycle changes of the solar spectrum. The findings show that, contrary to expectations, more light from the Sun does not always mean that the Earth becomes warmer.

Ramaty High-Energy Solar Spectroscopic Imager (RHESSI)

RHESSI was launched on 2002 February 5 and continues to operate successfully. The single RHESSI instrument is an imaging spectrometer observing the Sun in X-rays and γ -rays with energy resolution as fine as 1 keV (FWHM), angular resolution as fine as 2 arcseconds, and time resolution of a few seconds. Over 50,000 X-ray flares have been recorded to date. Of those, more than 7,000 have detectable emission above 12 keV, and 20 flares show γ -ray line emission. In addition, over 25,000 microflares have been detected above 3 keV.



Following an anomalous instrument turn off in 2010 April, the nine germanium detectors were successfully annealed for the second time to remove the effects of radiation damage. After the detectors were heated for a week at 100°C and cooled to their operating temperature of ~ 100 K, they all recovered much of their original sensitivity and energy resolution.

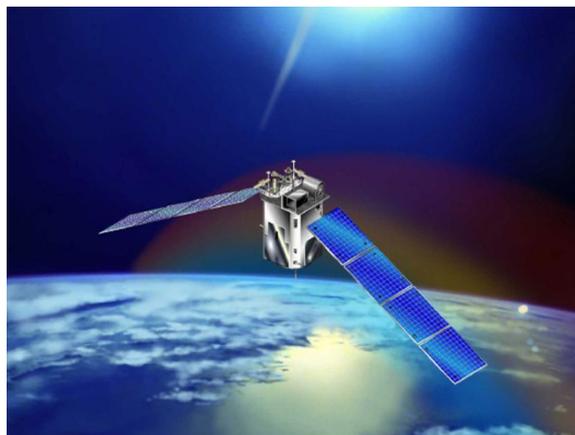
Over 60 international participants attended the 10th RHESSI science workshop that was held in Annapolis, MD, on 2010 August 1–5. Six working groups covered the following topics:

- RHESSI Imaging Techniques
- Polarization, Directivity, and Albedo
- γ -rays and Ions
- Multi-wavelength Observations
- Instrument Issues
- Particle Acceleration and Transport

The web site with copies of many of the PowerPoint presentations is on line at the following location: <http://rhessi10.wordpress.com/>

Thermosphere, Ionosphere, Mesosphere, Energetics, and Dynamics (TIMED)

The mesosphere, lower thermosphere, ionosphere (MLTI) region is a gateway between Earth’s environment and space, where the Sun’s energy is first deposited into Earth’s environment. TIMED is focusing on a portion of this atmospheric region located approximately 60–180 km above the surface (see figure below). The TIMED spacecraft was launched on 2001 December 7 from Vandenberg Air Force Base, CA, aboard a Delta II launch vehicle into a 625-km circular orbit with a 74.1° inclination.

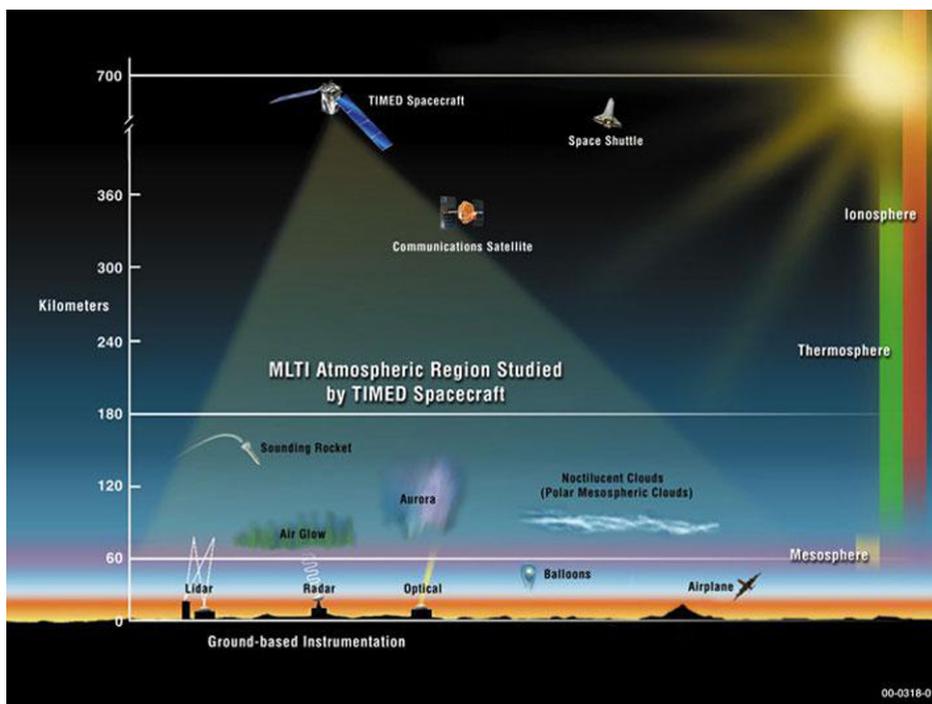


TIMED goals are to characterize the physics, dynamics, energetics, thermal structure, and composition of Earth’s MLTI region. The mission objectives are:

- To characterize and understand the solar cycle-induced variability of the MLTI region
- To address the processes related to human-induced variability of the mesosphere-lower thermosphere
- To quantify the solar EUV irradiance, the primary energy input to the MLTI region

HSD administered and monitored grants and contracts in FY2010, while GSFC has provided oversight of satellite activities. HSD scientists are making fundamental contributions to the interpretation of SABER data, as demonstrated in several presentations and publications.

TIMED mission has been extended for a fourth time through to 2014.

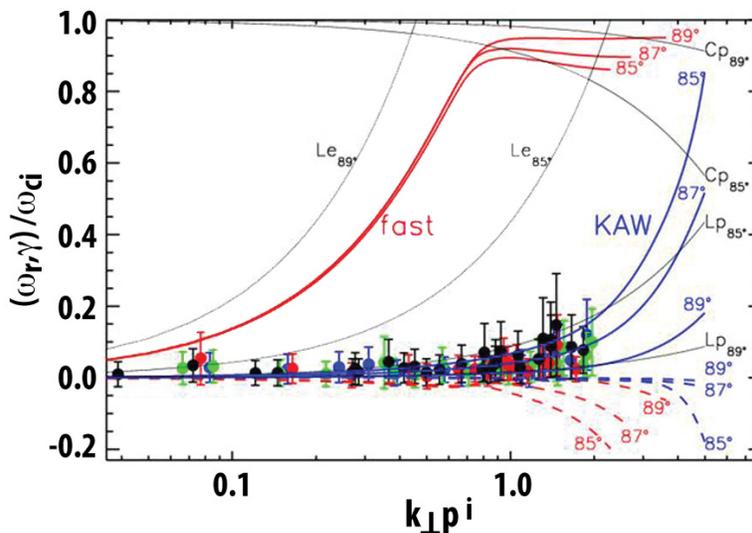


Cluster

Launched in 2000, Cluster is a revolutionary mission investigating the magnetosphere and near-Earth solar wind. The mission's uniqueness stems from its use of four spacecraft to distinguish the spatial and temporal properties of geospace boundaries. The Cluster spacecraft formation allows 3D snapshots of plasma structures and measurements of gradients in key plasma parameters. The capability to vary inter-spacecraft separations enables magnetospheric investigations on different spatial scales, making Cluster an active research tool. Cluster's multiscale era continues with configurations optimized to study the auroral acceleration region as well as orbits optimized for investigating turbulence in the solar wind. ESA has approved a mission extension through 2012 with probable further extension through 2014. NASA is committed to supporting Cluster through 2013. The goals of the extended mission include using the four Cluster spacecraft to:

- Characterize solar wind and plasma sheet turbulence
- Study the structure of the bow shock
- Determine exterior cusp structure
- Determine triggering and evolution of the auroral acceleration region
- Determine the extent of magnetotail bursty bulk flows and the width of reconnection regions
- Investigate E-fields in tail dynamics
- Study the plasma environment of radiation belts in the inner plasmasphere
- Determine chorus properties during magnetic storms and their effectiveness in accelerating MeV electrons, important for RBSP mission planning.
- Study solar wind-magnetosphere interaction and substorm processes in coordination with THEMIS

Since launch, the Project Office led by the U.S. Cluster Project Scientist at GSFC manages and coordinates the work of U.S. instrument teams and investigators. HSD scientists are involved in the data analysis.



The observed dispersion relations (dots) with estimated error bars, compared to the linear solutions of the Maxwell-Vlasov equations for three observed angles Θ_{kB} (the dashed lines are the damping rates). The black curves ($L_{p,e}$) are the proton and electron Landau resonances $w = k_{\parallel} V_{thi,e}$, and the curve C_p is the proton cyclotron resonance $\omega = \omega_{ci} - k_{\parallel} V_{thi}$ (the electron cyclotron resonance lies as expected out of the plotted frequency range).

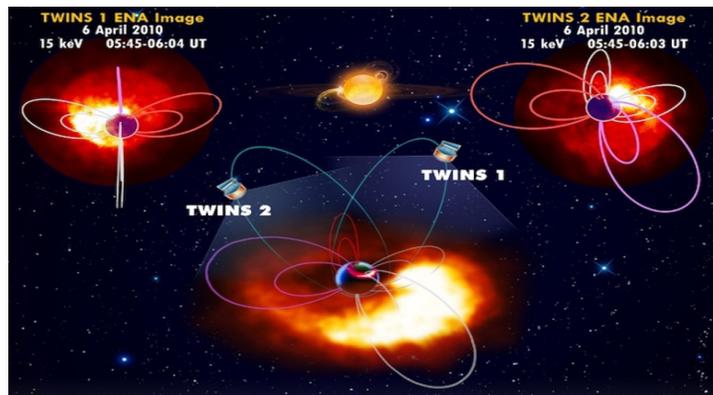
Two Wide-Angle Imaging Neutral-Atom Spectrometers (TWINS)

TWINS stereoscopically images the magnetosphere and the charge exchange ENAs over a broad energy range (~ 1 – 100 keV) by using two identical instruments on a pair of widely spaced high-altitude, high-inclination spacecraft. TWINS was launched into two nadir-pointing Molniya orbits at 63.4° inclination with apogees of $7.2 R_E$ and perigees of 1000 km.

The TWINS measurement strategy is to use a neutral-atom imager and a Lyman- α detector, both mounted on a rotating actuator platform to allow 360° azimuthal view. The neutral-atom imager covers ~ 1 – 100 keV energy range with $4^\circ \times 4^\circ$ angular resolution and 1-min time resolution. The Lyman- α imager monitors the density of the H geocorona. The scientific goals of the missions are to:

- Establish the global connectivities and causal relationships between processes in different regions of the Earth's magnetosphere
- Determine the structure and evolution of the storm-time magnetosphere
- Understand the energization and transport of magnetospheric plasma populations
- Characterize the storm-time sources and sinks of energetic magnetospheric plasmas

The project scientist from HSD participates in weekly science teleconferences, offers advice on achieving TWINS science goals, and assists in interpreting ENA images. HSD scientists participate in the analysis and interpretation of the TWINS data.



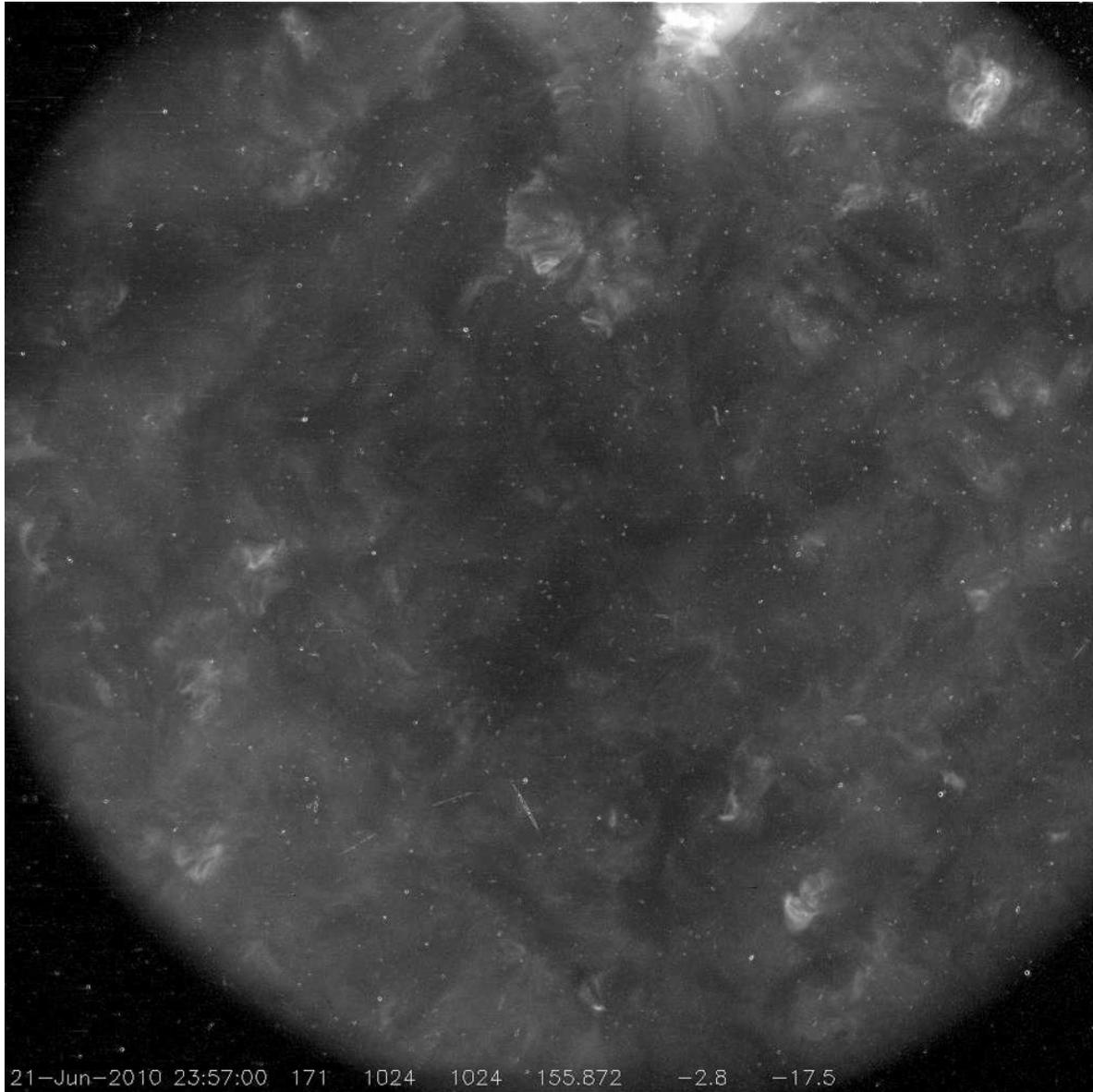
Significant Project Milestones in FY2010:

- There is open access is provided to all TWINS science data
- <http://cdaweb.gsfc.nasa.gov>
- <http://twins.swri.edu>
- <http://twinsmovies.swri.edu/> (TWINS stereo events page)
- TWINS successfully passed its NASA HQ End of Prime Mission (EOPM) review on 2010 September 28 and formally passed from prime into extended mission.
- Stereo ENA inversions are routinely performed to extract ring current ion distributions from TWINS images.

Transition Region And Coronal Explorer (TRACE)

The twelve-year-long mission of the remarkably successful Small Explorer TRACE, the Transition Region And Coronal Explorer, came to an end this summer. TRACE obtained its last image on 2010 June 21, and after several weeks of use as a test bed for new control laws for spacecraft slews, TRACE was passivated on 2010 September 17.

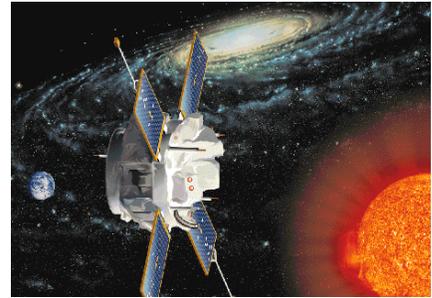
TRACE leaves behind over 1,000-refereed articles in the scientific literature, and a great leap forward in our understanding of the connection between solar surface magnetic fields and activity in the Sun's corona. Terminus est.



TRACE's last image of part of the Sun's inner corona, obtained at 2010 June 21, 23:57 UT.

Advanced Composition Explorer (ACE)

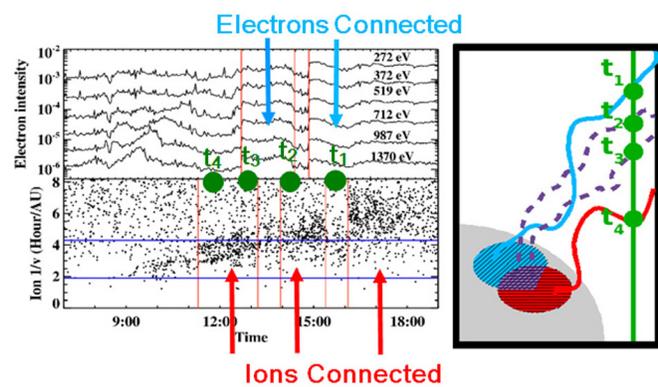
ACE was launched in August 1997 carrying six high-spectral-resolution instruments designed to measure the elemental, isotopic, and ionic charge-state composition of energetic nuclei from solar wind to cosmic ray energies, and three instruments to provide the interplanetary context for these studies. Since January 1998, ACE has been in orbit about the L1 point, 1.5×10^6 km sunward of Earth. Data from ACE are used to study the acceleration and transport of solar, interplanetary, and galactic particles with unprecedented precision. The figure below shows observations from a solar flare.



The magnetic connection is different for electrons and ions, demonstrating that these two components are accelerated at different sites on the Sun, as has been seen in X-ray and γ -ray observations.

The prime objective of ACE is to measure and compare the composition of several samples of matter, including the solar corona, the solar wind, and other interplanetary particle populations, the local interstellar medium, and galactic matter. The scientific questions for the extended mission are:

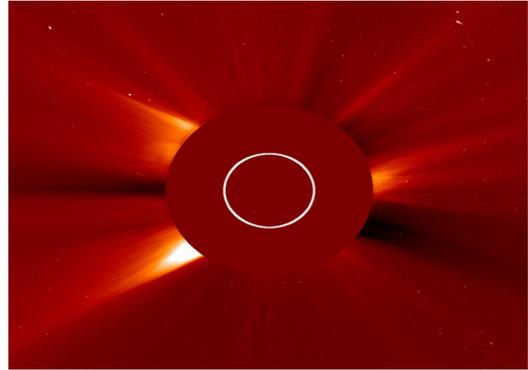
- How do the compositions of the Sun, solar wind, solar particles, interstellar medium, and cosmic rays differ, and why?
- How does the solar wind originate and evolve through the solar system?
- What is the structure of CMEs and other transients, and how do they evolve?
- How are seed particles fractionated and selected for acceleration to high energies?
- How are particles accelerated at the Sun, in the heliosphere, and in the galaxy?
- How are energetic particles transported in the heliosphere and the galaxy?
- What causes the solar wind, energetic particles, and cosmic rays to vary over the solar cycle?
- How does the solar wind control the dynamic heliosphere?
- How does the heliosphere interact with the interstellar medium?
- How do the solar wind, energetic particles, and cosmic rays contribute to space weather over the solar cycle?
- What solar and interplanetary signatures can be used to predict space weather?



Mission operations support for ACE is provided by the SSMO Project Office, Code 444 at GSFC. The ACE Deputy Project Scientist is in HSD. An HSD scientist is an instrument scientist for SIS and CRIS. ACE is in extended mission phase, and its usefulness to the heliophysics research community was re-affirmed by the 2010 Senior Review, which ranked ACE as #1 among operating missions for System Observatory Contribution.

Solar and Heliospheric Observatory (SOHO)

The SOHO white-light coronagraphs provide a Sun–Earth line view of both the evolution of and transient events in the solar corona. After successful intercalibration of helioseismology and EUV imaging instruments with SDO to enable observation of a complete 22-year solar magnetic cycle, those SOHO instruments will be deactivated. Spectrometers and particle instruments to continue monitoring of the H I Lyman- α resonant scattering corona, solar wind, and solar energetic particles will be operated as long as budget and throughput allow.



In addition to addressing three questions that had been troubling solar physics for decades—whether the “solar neutrino problem” lay in solar interior models or in neutrino physics, how the corona was heated to temperatures ~ 1.5 million K, and how the solar wind is accelerated—SOHO brought unique understanding to the causes and mechanisms of CME initiation, the propagation of CMEs through the heliosphere, variations in the TSI, the measurement of interstellar winds and the inference of local interstellar magnetic field direction, and the search for global solar buoyancy (“g-”) modes; and provided near-real-time, operational predictions of solar energetic particles during manned space missions.

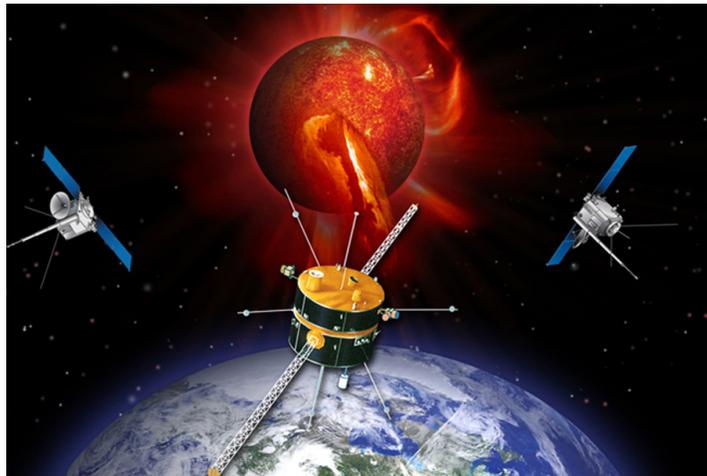
GSFC provides the NASA project management, mission operations, scientific operations, an analysis facility, and archive/data access facilities for the SOHO mission. HSD provides the NASA Project Scientist for the mission. The SDAC houses, among other data sets, all SOHO data other than the MDI helioseismology archive and serves it to the worldwide scientific community via the Internet, through both the SOHO archive interface and the VSO. SOHO has been in operation long enough (15 years) that there is no funding for science in the project budget beyond the most basic validation of the data stream.

Significant Project Milestones in FY2010

- Fifth mission extension (for three years), primarily to provide the Earth-Sun line coronal imaging SDO lacks
- Discovery of the 1900th comet of the mission, over 75% of which have been first detected in the publicly available coronagraph images by amateurs

Wind

Wind is a comprehensive solar wind laboratory for long-term in situ solar wind measurements. Wind is a spin-stabilized spacecraft launched in 1994 November 1 and placed in a halo orbit around the L1 Lagrange point, more than 200 R_E upstream of Earth, to observe the unperturbed solar wind that is about to impact the magnetosphere of Earth. Wind, together with ACE and SOHO, provide the 1-AU baseline for inner and outer heliospheric missions.



The primary science objectives of the Wind mission are to:

- Provide complete plasma, energetic particle, and magnetic field measurements for magnetospheric and ionospheric studies
- Investigate basic plasma processes occurring in the near-Earth solar wind
- Provide baseline, 1-AU, ecliptic plane observations for inner and outer heliospheric missions

Wind provides a third point of solar wind observations enhancing the science return of the STEREO mission and monitoring the solar wind input for geospace studies.

Significant Project Milestones in FY2010:

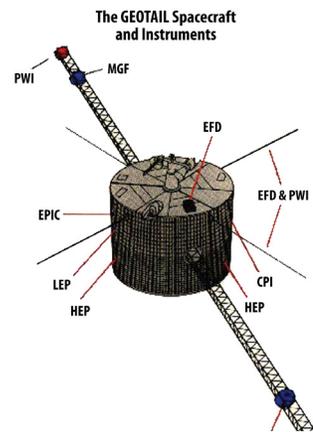
- Evidence for the dependence of magnetic reconnection on a combination of the plasma beta and magnetic shear. The results imply that magnetic reconnection is much more common close to the Sun.
- First observation of large-amplitude Bernstein waves upstream of a strong interplanetary shock.

Three of the still-functioning seven instruments were developed at GSFC, namely the Magnetic Field Investigation (MFI; A. Szabo, HSD, PI), the electron analyzer of the Solar Wind Experiment (SWE; K. Ogilvie, PI), and the high-energy particle instrument (Energetic Particles, Acceleration, Composition, and Transport—EPACT; T. Von Roseninge, PI). Moreover, a significant portion of the radio and plasma waves instrument was provided by GSFC (M. Kaiser, HSD, PI). The mission is also managed from Goddard with A. Szabo (HSD) serving as the Project Scientist and M. Collier (HSD) serving as the Deputy Project Scientist.

Wind will remain at L1 indefinitely and has sufficient consumables left for several more decades of operation.

Geotail

Geotail was launched in 1992 as a joint United States-Japan mission. It crosses all boundaries through which solar wind energy, momentum, and particles must pass to enter the magnetosphere. Knowledge of the physical processes operating at these boundaries is vital to understanding the flow of mass and energy from the Sun to the Earth's atmosphere. The long-lived Geotail spacecraft continues to provide critical and unique geospace measurements essential to fulfilling the key objectives of the HGO at minimal cost.



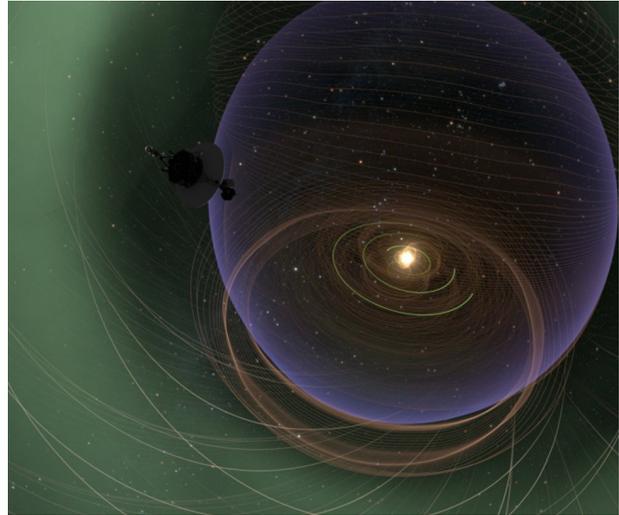
During the current extended mission, the Geotail science focuses are:

- Providing extensive coverage of the magnetospheric boundary layer to delineate mechanisms controlling the entry and transport of plasma into the magnetosphere that is then energized to produce magnetic storms
- Providing supplementary measurements to THEMIS to reveal the spatial and temporal scales of substorm phenomena in the magnetotail
- Providing near-Earth plasma and magnetic field measurements as Geotail spends about 35% of its time in the solar wind
- Providing an important complementary data source for validation of global simulations
- Providing observations that define the location and physics of tail magnetic reconnection and particle acceleration
- Determining energetic-particle environments up to, and including, penetrating γ -rays

GSFC provides ground-data-system support for Geotail. Deep Space Network (DSN) telemetry data are transferred to the GSFC data system, which performs the initial reduction and merging with trajectory data provided by the Japanese. Data for the experiments are stored and can be accessed by both Japanese and American experimenters. Key parameters are produced directly from the DSN playback data at GSFC and are available from the Coordinated Data Analysis Web (CDAWeb). HSD provides the project scientist for the mission.

Voyager

The Voyager spacecraft continue their epic journey of discovery, traveling through a vast unknown region of the heliosphere on their way to the interstellar medium. Both Voyagers are now traversing the heliosheath, with the first crossings of the heliopause and the first in situ observations of the interstellar medium still to come. The twin Voyager 1 and 2 spacecraft continue exploring where no spacecraft from Earth has flown before. Now in the 32nd year after their 1977 launches, Voyagers 1 and 2 are 16 and 13 x 10⁹ km from the Sun, respectively, and they are approaching the boundary region—the heliopause—where the Sun’s dominance of the environment ends and interstellar space begins. Voyager 1, more than three times the distance of Pluto, is farther from Earth than any other human-made object and speeding outward at more than 65,000 km/hr. Both spacecraft are still sending scientific information about their surroundings through the DSN. The figure above shows a model of the magnetic fields of the heliosphere and the local interstellar cloud. Data from the two Voyagers, and the IBEX spacecraft, have helped determine the strength and direction of the magnetic field immediately outside the solar system.



The goals for the Voyager spacecraft are to explore the interaction of the heliosphere with the local interstellar medium and to study the heliosheath. Major mysteries remain unresolved, such as the size and shape of the heliosphere and the source and acceleration mechanism for the anomalous cosmic rays. The Voyager Interstellar Mission (VIM), in combination with IBEX, should be able to answer some of these questions. The nature of the turbulence and the dynamics of major solar wind structures downstream of the termination shock will also be examined by the VIM. GSFC’s principal contribution is through the Magnetometer (MAG) instrument.

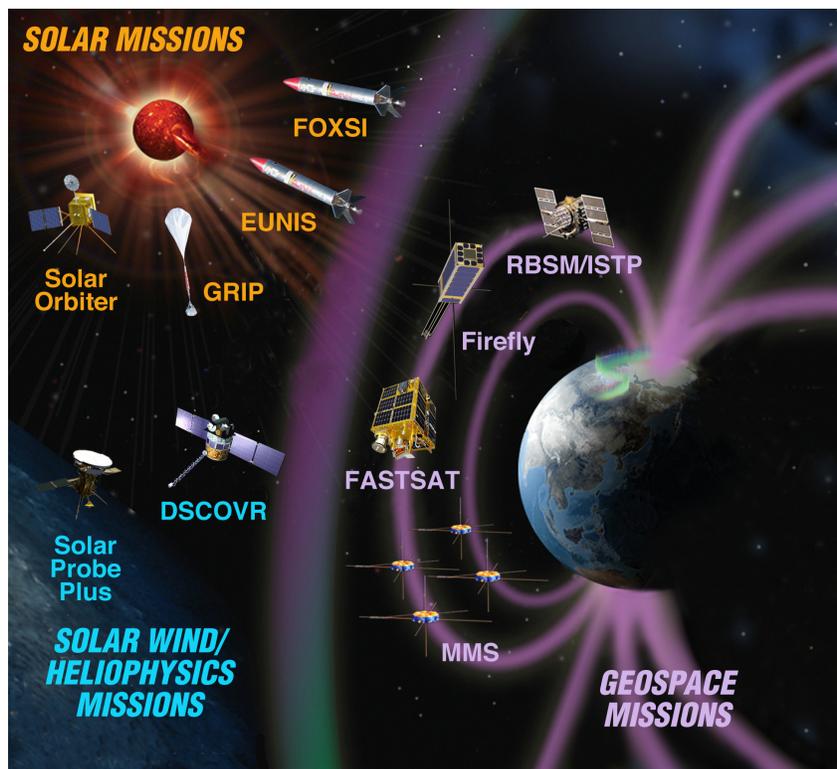


Voyager enters the heliosheath and in 10 years will likely be in interstellar space.

APPENDIX D: Missions in Development

Introduction

Currently, there are a number of future heliophysics missions in various stages of development. Key to the future of the HGO and the strength of this discipline are the vitality of its strategic vision and the pipeline of new space missions that are required to realize the vision. These missions always build on past scientific achievements and technical capabilities, but it is essential that they produce more than incremental results and that some of the more challenging missions be undertaken not in spite of, but rather because of, the challenges they present to heliophysics and NASA. The larger missions are part of the STP or LWS programs. Heliophysics expects a steady stream of grassroots-developed, PI-led Explorer missions that will achieve more focused, nearer-term science objectives. There are mission-of-opportunity payloads on other government and commercial spacecraft, and collaborations involving international missions (as with Hinode and SOHO). GSFC HSD scientists serve as study scientists and as members of the Science and Technology Definition Teams of these missions.



The Next-Generation HGO Elements.

Two missions will focus on the ionosphere, mesosphere, and thermosphere regions; three missions will solve key questions regarding magnetic reconnection and charged-particle acceleration in the magnetosphere; four missions will measure the solar wind, determine its acceleration mechanism in the corona, and its evolution as it moves out into the heliosphere; and four missions will probe the outer layers of the Sun, its atmosphere, and the eruption of flares and coronal mass ejections.

NASA heliophysics missions planned to fly beyond FY2010:

Mission	Planned Launch	Project/Mission Scientist	Scientific Studies of:
FASTSAT	November 2010	John Sigwarth (HSD) Doug Rowland (HSD) Michael Collier (695)	Ionosphere and thermosphere
EUNIS	2011	Doug Rabin (HSD)	The Sun
Firefly	2011	Doug Rowland (HSD)	Lightning discharges
FOXSI	2011	Steven Christe (HSD)	The Sun
RBSP	2012	Barry Mauk (APL) David Sibeck (HSD)	Earth's radiation belts
GRIPS	2012	Gordon Hurford (UCB) Albert Shih (HSD)	Solar flares
DSCOVR	2013	Adam Szabo (HSD)	Solar wind
MMS	2013	Tom Moore (HSD)	Magnetosphere
Solar Orbiter	2017	Chris St. Cyr (HSD)	Active region evolution
SPP	2018	Robert Decker (APL) Adam Szabo (HSD) Marco Velli (JPL)	Solar wind

The nature and timing of the missions may change as a result of the NASA Heliophysics Roadmap study and the National Research Council (NRC) decadal survey.

Fast Affordable Science and Technology Satellite (FASTSAT)

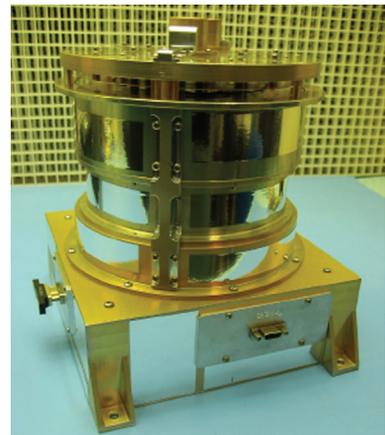
The Fast Affordable Science and Technology Satellite (FASTSAT) is a 140-kg platform that can carry multiple small instruments or experiments to low-Earth orbit on a wide range of expendable launch vehicles for a fraction of the cost traditionally required for such missions. It is scheduled for launch from Kodiak, AK, in November 2010.



FASTSAT will carry six small payloads, including three technology demonstration experiments and three atmospheric research instruments. HSD is responsible for two FASTSAT instruments: the Thermospheric Temperature Imager (TTI), PI John Sigwarth (670); and the Plasma Impedance Spectrum Analyzer (PISA), PI Douglas Rowland (674). GSFC is responsible for a third instrument, the Miniature Imager for Neutral Ionospheric atoms and Magnetospheric Electrons (MINI-ME), PI Michael Collier (695).

- **MINI-ME**, a neutral-atom imager, will observe the neutral atom inputs to ionospheric heating which can be important during high levels of magnetospheric activity
- **PISA**, a plasma impedance spectrometer, will measure simultaneously the local electron densities and temperatures as well as measure small-scale density structure (500-m spatial scale) during these active periods
- **TTI**, a thermospheric imager, will remotely determine the thermospheric temperature response to this magnetospheric activity

Together, these observations will contribute significantly to a comprehensive understanding of the flow storm-time terrestrial magnetosphere. Their development was supported by IRAD funding and included students from the U.S. Naval Academy. The instruments have been successfully integrated onto the satellite and tested in April. Each of the GSFC instruments represents a science and technology demonstration to address future mission opportunities for HSD.



MINI-ME Flight Unit

[FASTSAT was successfully launched on 2010 November 19 (FY2011) and has completed initial checkout. The instruments are performing nominally.]

Extreme Ultraviolet Normal Incidence Spectrograph (EUNIS)

The Extreme-Ultraviolet Normal-Incidence Spectrograph (EUNIS) is a Goddard-designed and operated sounding rocket instrument that obtains imaged high-resolution solar spectra. It has had two successful flights, on 2006 April 12 and 2007 November 16, providing spectra of unprecedented temporal resolution (<10 s), as well as radiometric calibrations for a number of orbiting solar experiments on both occasions (including the SOHO Coronal Diagnostic Spectrometer and the Hinode EUV Imaging Spectrometer). EUNIS-06 and EUNIS-07 obtained spectra in the 170–205 Å and 300–370 Å wavelength regions, calibrated to an absolute radiometric accuracy of $\pm 15\%$.

Scientific and Technical Goals:

To probe the structure and dynamics of the inner solar corona

To study evolving and transient structures by obtaining spectra at high cadence

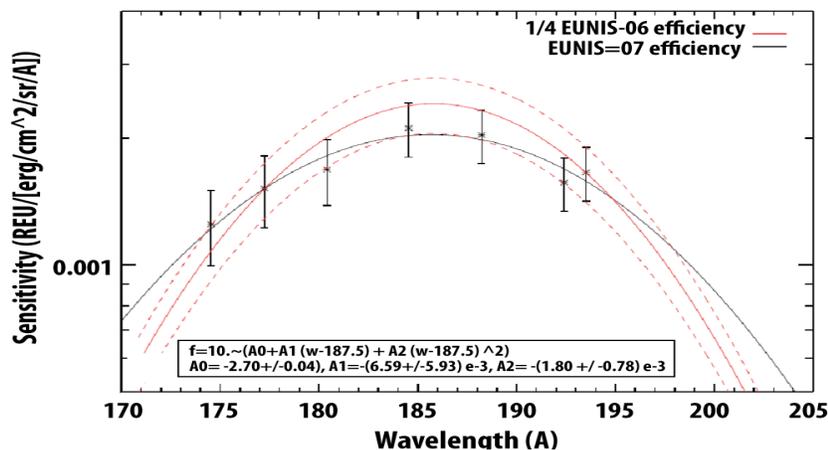
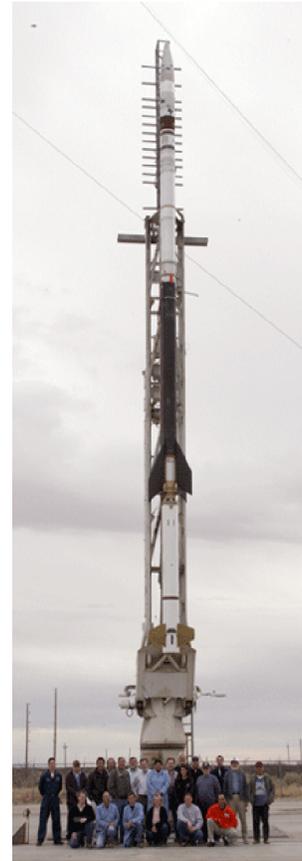
To study diagnostics of wave heating and reconnection

To provide absolute radiometric calibration of orbital instruments

To demonstrate new technology in flight

HSD provides the Principal Investigator (D. Rabin), several Co-Investigators (R. J. Thomas, J. Brosius, A. Daw, J. Klimchuk) and the Systems Engineer (J. P. Haas) and engineering team.

The third flight of EUNIS is expected to occur in April or May of 2011. The key scientific goal is to obtain spectra above the solar limb that can be used to investigate wave heating in the low corona. Off-limb observations will be enabled by the first flight demonstration of cooled active pixel sensor (APS) arrays, which exhibit dramatically lower noise than the uncooled APS arrays used in previous flights. Additionally, EUNIS-11 will investigate the diagnostically rich 524–630-Å spectral range using an advanced toroidal variable-line-space diffraction grating.



The radiometric calibration of the EUNIS-07 short-wavelength channel enabled the intensities of features in a common field of view with Hinode/EIS to be measured in absolute units ($\text{erg cm}^{-2}/\text{sr}^{-1} \text{Å}^{-1}$).

Firefly

Firefly is a SmallSat program funded by NSF that is designed to study particle acceleration due to lightning. Lightning generates heat, light, and noise in the Earth's atmosphere but also accelerates electrons and produces γ -rays. These high-energy emissions were originally discovered by GRO and have also been detected by RHESSI. They can only be observed from LEO satellites. Firefly is scheduled for launch in FY2011. The diminutive spacecraft, which is about the size of a football, carries two instruments:



- A BGO γ -ray detector, which measures the time of arrival of X-ray and γ -ray photons for the terrestrial γ -ray, flashes. It can also detect electrons accelerated to several hundred to a few MeV energies.
- A VLF receiver/photometer, which will monitor VLF radio waves originating from lightning bursts in the 10s, Hz to 100s kHz range. It will also measure the optical output of the lightning at high time resolution.

The scientific goals of Firefly include determining:

- How are γ -ray flashes produced?
- What types of lightning produce γ -ray flashes and what makes them different from lightning that does not produce such emissions?
- How common are γ -ray flashes?
- How do γ -ray flashes affect the Earth's upper atmosphere?
- Do γ -ray flashes supply electrons to the inner radiation belts?

Firefly is a collaborative effort between NASA GSFC and Siena College, which supply co-principal investigators for the mission. GSFC's co-PI Doug Rowland (HSD) and a Co-I Joanne Hill is a Co-I on the program. The team also includes USRA, the Hawk Institute, and the University of Maryland, Eastern Shore.

Focusing Optics X-ray Solar Imager (FOXSI)

Particle acceleration in solar flares and its contribution to coronal heating are among the main unsolved problems in heliophysics. Hard X-ray (HXR) observations are a powerful diagnostic tool, providing quantitative measurements of flare-accelerated electrons, yet bremsstrahlung emission depends on the density of the ambient medium. Present-day HXR instrumentation does not have the sensitivity to see faint HXR emission from electrons traveling in the corona, nor the dynamic range to see such faint emission in the presence of bright HXR sources in the chromosphere. Existing observations therefore show us only where energetic electrons are stopped, but not where they are accelerated, nor along what path they escape from the acceleration site. HXR focusing optics can now provide both the sensitivity and dynamic range to image electrons traveling in the corona. Such an instrument will be able to image where electrons are accelerated, along which field line they travel away from the acceleration site, where they are stopped, and how some electrons escape into interplanetary space.



The Focusing Optics X-ray Solar Imager (FOXSI) is a sounding rocket payload funded under the NASA Low Cost Access to Space (LCAS) program to test HXR focusing optics combined with silicon strip detectors for solar observations. FOXSI will be a pathfinder for the future generation of hard X-ray solar spectroscopic imagers.

The short duration of a rocket flight (~360 s) restricts FOXSI observations to those events that occur very frequently or to continuous emission. FOXSI will

- Search for non-thermal counterparts of network flares occurring in the so-called quiet Sun
- Explore the flare frequency distribution of active region microflares with 100 times better sensitivity than in previous missions
- Determine the differential emission measure of hot plasma in active regions
- Search for HXR emission associated with radio-emitting electron beams in order to determine the properties of the accelerated electrons

Dr. Steven Christe (671) is the project scientist/project manager for this mission.

FOXSI is on schedule for a first launch in October 2011.

Radiation Belt Storm Probes (RBSP)

Charged particles in the Van Allen radiation belts of the inner magnetosphere have energies sufficient to pose a hazard to both astronauts and spacecraft. A host of processes have been proposed to account for the variations in strength of the radiation belts as a function of time and location. The distances separating the RBSP spacecraft will vary over the course of this two-spacecraft mission, enabling researchers to distinguish between spatial and temporal effects, determine cause and effect, and identify the spatial extent of phenomena relevant to radiation belt physics. Both spacecraft will carry beacons to provide real-time observations of the radiation belts to space weather forecasters.



Both spacecraft will carry beacons to provide real-time observations of the radiation belts to space weather forecasters.

The objectives of the RBSP mission are to determine:

- Which physical processes produce radiation belt enhancement events
- The dominant mechanisms for relativistic electron loss
- How ring current and other geomagnetic processes affect radiation belt behavior

GSFC retains overall technical authority, but applies “light-touch” management over this mission, which has been assigned to JHU/APL. All Project Science responsibilities have been assigned to JHU/APL. HSD involvement includes mission scientist, David Sibeck, and Deputy Mission scientists, Joe Grebowsky and Shri Kanekal. Shri Kanekal is also an ECT suite Co-I and the instrument scientist for REPT.

Following a three-day Critical Design Review in December, during which team members presented every detail of their work to a NASA-appointed review panel, RBSP is now in the “flight build phase.” The team will now begin building the instruments and spacecraft, and testing their hardware and software. Each instrument team is building two identical versions of their instruments, so that both probes can make the exact same measurements as they orbit Earth.

Spacecraft and instruments have all successfully completed their critical design reviews, preparatory for the mission CDR scheduled for December 2009. The planned launch date is 2012 May 18.

Gamma-Ray Imager/Polarimeter for Solar flares (GRIPS)

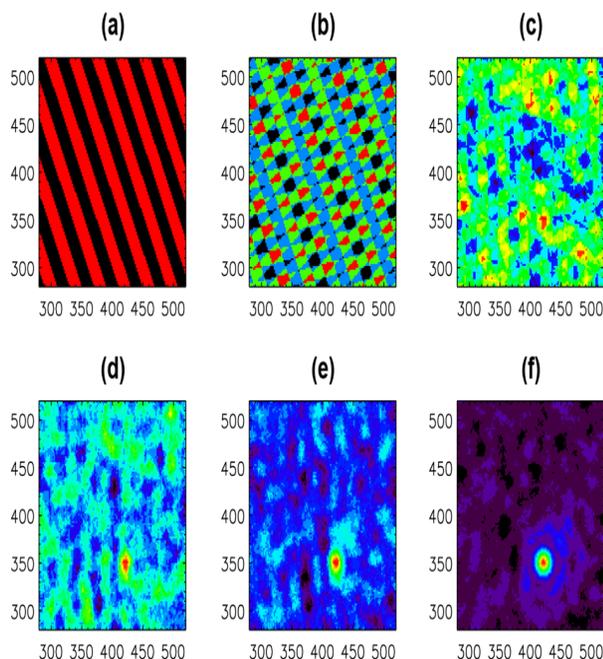
Not only does a large fraction of the energy released in solar flares come out in the form of accelerated particles, this energy is roughly equipartitioned between ions and electrons. While energetic electrons can be studied by their X-ray and microwave signatures, energetic ions must be studied by their γ -ray signatures. RHESSI was the first mission to spatially resolve ion-associated γ -ray sources, but only in the largest flare. A new instrument with improved angular resolution is needed to investigate differences between ion and electron acceleration.



The Gamma-Ray Imager/Polarimeter for Solar flares (GRIPS) is a NASA Low-Cost-Access-to-Space (LCAS) balloon mission being led by the University of California, Berkeley. GRIPS combines a new germanium detector technology with a novel γ -ray imaging design to provide a near-optimal combination of high-resolution imaging, spectroscopy, and polarimetry of solar-flare γ -ray/hard X-ray emissions from ~ 20 keV to > 10 MeV, with an unparalleled γ -ray angular resolution of 12.5 arc sec (three times better than RHESSI). GRIPS will address the following questions:

- What causes the spatial separation between energetic electrons producing hard X-rays and energetic ions producing γ -ray lines?
- What is the angular distribution of accelerated electrons and ions?
- Why do relativistic electrons dominate in the corona?
- How does the composition of accelerated and ambient material vary with space and time, and why?

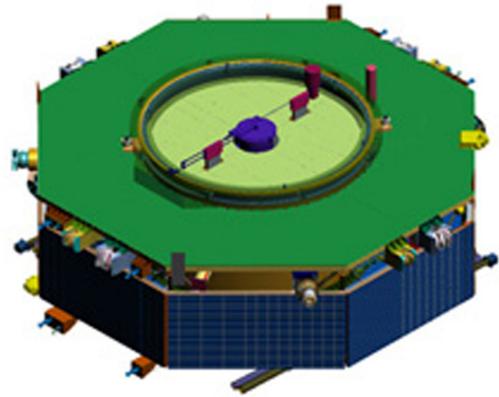
GRIPS is being developed and built as a collaboration between UC Berkeley, GSFC, LBNL, and UC Santa Cruz. Dr. Albert Shih (671) is the project scientist/project manager for this mission. GRIPS is slated to have a continental-US test flight in the spring of 2012. This one-day flight will test the instrument by observing any hard X-ray flares that occur as well as the Crab Nebula for calibration. Anticipated future long-duration balloon flights from Antarctica will provide GRIPS with the necessary flight times to have a good chance of observing γ -ray flares.



Simulated performance of the GRIPS imaging approach. Panel (a) shows the backprojection of one photon to a series of stripes on the Sun. Panels (b) through (f) show the image improving as more photons are collected: 3, 10, 30, 100, and 1000 photons, respectively. The photons combine to produce a point-response function that is virtually free of sidelobes.

Magnetospheric MultiScale (MMS)

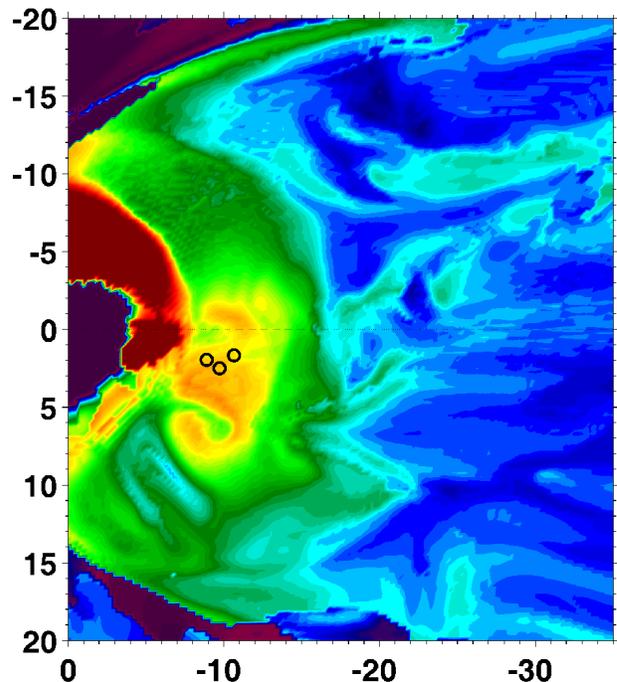
Magnetic fields play the role of connective fibers in space plasmas, giving them a coherence and structure that is easily seen in images of the solar corona. Complex motions of space plasmas store energy in the stretching and twisting of magnetic fields that results. This energy is released when the fields can no longer contain the plasma expansion, and a disconnection frees part of the plasma from the rest. When two different plasmas interact, magnetic connections can link them, also releasing energy. The results include heated plasma and accelerated particles. The reconnection process involves fast moving phenomena at scales so small they have not to date been observable from spacecraft or in the laboratory.



The goal of the Magnetospheric Multiscale (MMS) mission is to deploy high-speed instruments that can capture the small-scale, fast-moving site of reconnection and determine the processes responsible for its initiation and evolution. MMS will resolve the role played by electron inertial effects and turbulent dissipation in magnetic reconnection as it measures the rate of magnetic reconnection and other parameters that control it.

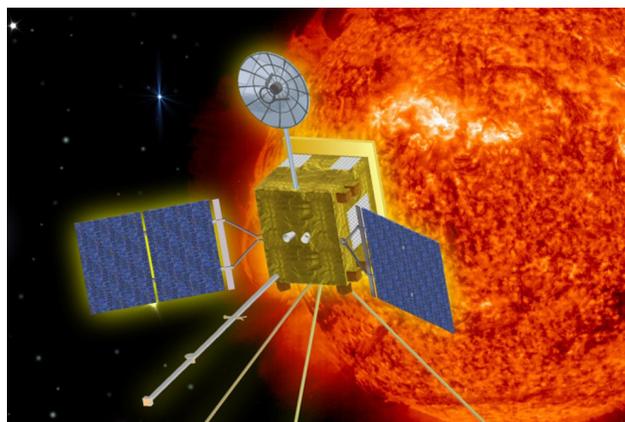
MMS, including the Fast Plasma Instrument, is a major GSFC project involving many personnel and resources of the HSD. The project is managed at GSFC, and the four spacecraft will be built at GSFC. The Project Scientist is T. Moore, and the two Deputy Project Scientists are M. Adrian and G. Le. C. Pollock leads the Fast Plasma Instrument (FPI), including Dual Electron Sensors built and tested at GSFC, and the Dual Ion Sensors built in Japan and tested at MSFC. M. Hesse leads the Theory and Modeling Team, J. Slavin and G. Le are members of the Fields Team, and M. Goldstein leads one of the Interdisciplinary Science Teams. A major renovation and expansion of the HSD laboratory facilities was completed this year. MMS completed CDR, is now in Phase D, and proceeding into fabrication, integration, and test.

Magnetic reconnection simulated in the magnetotail



Solar Orbiter

Solar Orbiter is a joint ESA/NASA mission and will carry its telescopes to less than one quarter of the Earth's distance from the Sun, where sunlight will be 20 times more intense than for satellites in Earth orbit. The spacecraft will have to endure powerful bursts of atomic particles from explosions in the solar atmosphere. The result of enduring these extreme conditions will be higher-resolution images obtained together with unprecedented measurements of the local near-Sun phenomena. The images will show details down to 200 km.



Solar Orbiter will carry 10 instruments: an energetic-particle detector, EUV imager, magnetometer, coronagraph, magnetograph, plasma wave monitor, heliospheric imager, EUV spectrometer-ray imager, solar wind plasma analyzer, super-thermal ion spectrograph, and a heavy ion sensor.

The scientific goals of Solar Orbiter are to:

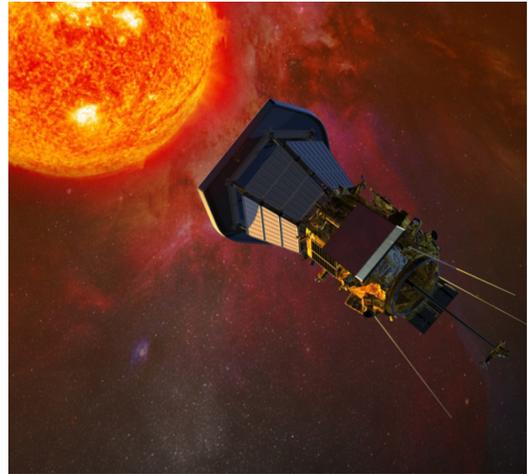
- Determine the in situ properties and dynamics of plasma, fields and particles in the near-Sun heliosphere
- Survey the fine detail of the Sun's magnetized atmosphere
- Identify the links between activity on the Sun's surface and the resulting evolution of the corona and inner heliosphere, using solar co-rotation passes
- Observe and characterize the Sun's polar regions and equatorial corona from high latitudes

GSFC hosted the U.S. Solar Orbiter Project Office and is managing four PI teams and the launch vehicle. Hardware for two of those US-contributed instruments (SPICE and SWA-HIS) are being provided by GSFC Co-I's.

The Solar Orbiter mission was one of three missions (of 52 originally proposed and of the six that made it into the phase A study) selected by ESA for further study in February as part of its cosmic visions program. Of these, two will finally be chosen for launch, no earlier than 2017.

Solar Probe Plus (SP+)

Solar Probe Plus (SP+) is humanity's first visit to the near-Sun environment to explore the complex and time-varying interplay of the Sun and Earth, which affects human activity. SP+ will determine where and what physical processes heat the corona and accelerate the solar wind to its supersonic velocity. A combined remote-sensing and in situ sampling from within the solar corona itself will provide a "ground truth" never before available from astronomical measurements made from spacecraft in Earth's orbit or at the Lagrange points. SP+ is currently under study as part of NASA's SMD.



Artist concept of the Solar Probe+ spacecraft

The baseline mission provides for 24 perihelion passes inside 0.16 AU ($35 R_{\odot}$), with 19 passes occurring within $20 R_{\odot}$ of the Sun. The first near-Sun pass occurs 3 months after launch, at a heliocentric distance of $35 R_{\odot}$. Over the next several years, successive Venus gravity assist (VGA) maneuvers gradually lower the perihelia to $\sim 9.5 R_{\odot}$ —by far the closest any spacecraft has ever come to the Sun. The spacecraft completes its nominal mission with three passes, separated by 88 days, at this distance.

Although the SP+ science objectives remain the same as those established for Solar Probe 2005, the new mission design differs dramatically from the 2005 design (as well as from all previous Solar Probe mission designs since the 1970s). The 2005, and earlier, missions involved one or two flybys of the Sun at a perihelion distance of $4 R_{\odot}$ by a spacecraft placed into a solar polar orbit by means of a Jupiter gravity assist. In contrast, SP+ remains nearly in the ecliptic plane and makes many near-Sun passes at increasingly lower perihelia.

GSFC will build a large fraction of the high-energy particle detector (EPI-Hi) for SP+ under the direction of Eric Christian (672). Goddard will also provide the fluxgate magnetometers (695). In addition, seven science Co-Is have been selected from GSFC along with the NASA mission scientist, Adam Szabo (672).

NASA selected four instrument teams for SP+ on 2010 September 2: solar wind proton, alpha particle, and electron detector led by the Smithsonian Astrophysical Observatory; a magnetic and electric field experiment led by the UCB; a pair of energetic particle detectors led by the SWRI; and a wide field heliospheric imager led by the NRL.

Deep Space Climate Observatory (DSCOVR)

The Deep Space Climate Observatory (DSCOVR), formerly known as Triana, is a NOAA-funded mission to observe the undisturbed solar wind in real time at the Earth first Lagrange (L1) point. The spacecraft is currently in long-term storage in a GSFC clean room awaiting NOAA funding to start refurbishment

The primary objectives of the DSCOVR mission are to provide real-time solar wind magnetic field and thermal proton observations that allows ~30-45 minutes space weather forecasting at Earth. As secondary objectives, DSCOVR has the following science goals:

- Provide high time resolution (~10 Hz) solar wind proton and alpha reduced distribution function and interplanetary magnetic field measurements to enable the study of kinetic structures in the solar wind
- Provide > 1 Hz 3D electron distribution function measurements to study the evolution of the electron strahl and heat flux
- Provide remote sensing images of the Earth in various wavelengths for Earth science objectives



The DSCOVR spacecraft in a Goddard clean room awaiting refurbishment for a December 2013 launch.

Significant Project Milestones in FY2010

- The Earth science instruments (EPIC and NISTAR) have been successfully refurbished
- The procurement of a longer (7 m) magnetometer boom will improve the accuracy of the magnetometer measurements

GSFC will be funded by NOAA to refurbish the DSCOVR spacecraft and all its science instruments. The magnetometer and electron electrostatic analyzer was built at Goddard. Goddard is responsible for all space weather data production software. A. Szabo (672) is the DSCOVR project scientist.

DSCOVR is awaiting Congressional appropriation to NOAA to start the refurbishment process. A USAF launch vehicle is allocated for a December 2013 launch.

APPENDIX E: Acronyms

1D One Dimensional
 2D Two Dimensional
 3D Three Dimensional
 3DP [Abbreviation for] 3D Plasma and Energetic Particle Analyzer (on Wind)

aa [Geomagnetic activity index based on 3-hourly] antipodal amplitudes
 AAS..... American Astronomical Society
 AB Bachelor of Arts
 ACE..... Advanced Composition Explorer
 ACES..... Auroral Current and Electrodynamics Structure (sounding rocket)
 ACRIM..... Active Cavity Radiometer Irradiance Monitor (e.g., on SMM)
 AE Atmosphere Explorer
 AFRL..... Air Force Research Laboratory
 AGU..... American Geophysical Union
 AIA..... Atmospheric Imaging Assembly (on SDO)
 AIM..... Aeronomy of Ice in the Mesosphere (satellite)
 AIP American Institute of Physics
 AIP Astrophysical Institute of Potsdam
 AISRP..... Applied Information Systems Research Program
 ALICE A Large Isotopic Composition Experiment (Balloon-borne instrument)
 ALI-ARMS..... Accelerated Lambda Iterations for Atmospheric Radiation and
 Molecular Spectra (model)
 AMS American Meteorological Society
 APL..... Applied Physics Laboratory (of JHU)
 ARMS..... Adaptively Refined MHD Solver
 ASI..... All-Sky Imager(s)
 ASIC..... Application-Specific Integrated Circuit
 ASTID..... Astrobiology Science and Technology Instrument Development
 (NASA program)
 Astromag..... Not an acronym (Space Station Attached Payload (never built))
 ATC Advanced Technology Center (of Lockheed Martin)
 AU Astronomical Unit, the Earth-Sun distance, $\sim 1.5 \times 10^6$ km

BA..... Bachelor of Arts
 BATSE..... Burst and Transient Source Experiment (on CGRO)
 BATS-R-US Block-Adaptive-Tree-Solarwind-Roe-Upwind-Scheme (model)
 BP Bright Point (Coronal)
 BS Bachelor of Science
 BSc..... Bachelor of Science

CAPS Cassini Plasma Spectrometer
 CAS Chinese Academy of Sciences
 CAWSES..... Climate and Weather of the Sun-Earth System
 (international SCOSTEP program)
 CBC..... Canadian Broadcasting Corporation

CCD.....	Charge-Coupled Device
CCMC.....	Community Coordinated Modeling Center (at GSFC)
CDAP.....	Cassini Data Analysis Program
CDAW.....	Coordinated Data Analysis Workshop
CDAWeb	Coordinated Data Analysis (Workshop) Web (at NASA/GSFC SPDF)
CDF	Common Data Format
CDR.....	Critical Design Review
CDS.....	Coronal Diagnostic Spectrometer (on SOHO)
CESR.....	Centre d'Etude Spatiale des Rayonnements (in Toulouse, France)
CETP.....	Centre d'étude des Environnements Terrestre et Planétaire (France)
CFC.....	Combined Federal Campaign
CFC.....	Chlorofluorocarbons
CGRO	Compton Gamma Ray Observatory
CHIANTI.....	Not an acronym. An atomic database for emission from spectral lines and continuum
CINDI.....	Coupled Ion-Neutral Dynamic Investigations (NASA Mission of Opportunity, part of C/NOFS payload)
CIPS	Cloud Imaging and Particle Size Experiment (on AIM)
CIT.....	California Institute of Technology
CLARREO	CLimate Absolute Radiance and REfractivity Observatory
CME	Coronal Mass Ejection
CMU	Carnegie Mellon University
C/NOFS	Communications/Navigation Outage Forecasting System (USAF)
CNRS.....	Centre National de la Recherche Scientifique (France)
COHOWeb	Coordinated Heliospheric Observations Web (NSSDC interface)
Co-I	Co-Investigator
COI	Cone of Influence
COR1	Inner coronagraph on STEREO SECCHI
COSPAR.....	Committee on Space Research
CRCM.....	Comprehensive Ring Current Model
CRIS.....	Cosmic Ray Isotope Spectrometer (on ACE)
CRESST	Center for Research and Exploration in Space Science & Technology
CRRES	Combined Release and Radiation Effects Satellite
CRS	Cosmic Ray Subsystem (on Voyager)
CTIP.....	Coupled Thermosphere-Ionosphere-Plasmasphere (model)
CTIPe.....	Coupled Thermosphere-Ionosphere-Plasmasphere electrodynamics (model)
CUA	Catholic University of America

DC.....	Direct Current
DDCS.....	Deputy Director's Council of Science
DEM	Differential Emission Measure
DES	Dual Electron Spectrometer (component of MMS FAST)
DSCOVr	Deep Space Climate ObserVatoRy
DL	Double Layer
DoD	Department of Defense (US)
DMSP.....	Defense Meteorological Satellites Program
DREAM	Dynamic Response of the Environment At the Moon

DSN	Deep Space Network
Dst.....	Disturbance storm time (space weather index)
<hr/>	
EAF.....	Experimenters' Analysis Facility
ECCS.....	European Cooperation for Space Standardization
ECHOES.....	Electron Concentration vs. Height from an Orbiting Electromagnetic Sounder
EIS.....	Extreme-ultraviolet (EUV) Imaging Spectrometer (on Hinode)
EIT	EUV Imaging Telescope (on SOHO)
ENA.....	Energetic Neutral Atoms
ENLIL	Not an acronym. A time-dependent 3D MHD model of the heliosphere, named after the Sumerian god of the wind
EOF	Experimenters' Operations Facility
Eos.....	Not an acronym. Weekly newspaper of the Earth and Space Sciences community, published by the AGU and named after the Greek goddess of dawn.
EPACT	Energetic Particles: Acceleration, Composition, and Transport (on Wind)
EPI.....	Energetic Particle Instrument (to fly on SP+)
EPI-HI.....	EPI High-energy Instrument
E/PO, EPO.....	Education and Public Outreach
E/POESS	Education and Public Outreach for Earth and Space Science
EPRI	Electrical Power Research Institute
ESA.....	European Space Agency
ESA.....	Empirical Shock Arrival
ESF	Equatorial Spread F
EUNIS.....	Extreme-Ultraviolet Normal-Incidence Spectrograph (rocket payload)
EUV.....	Extreme Ultraviolet
EUVE	EUV Explorer
EUVS.....	EUV Sensor (in GOES-R EXIS instrument package)
EVE	Extreme ultraviolet Variability Experiment (on SDO)
EXIS	Extreme ultraviolet and X-ray Irradiance Sensors (on GOES-R; includes EUVS and updated XRS)
<hr/>	
FAC	Field Aligned Current
FAST	Fast Auroral Snapshot Explorer
FASTSat.....	Fast, Affordable, Science and Technology Satellite
FGM.....	Fluxgate Magnetometer (e.g., on ST5 and Cluster)
FIP.....	First Ionization Potential
FISM	Flare Irradiance Spectral Model
FITS	Flexible Image Transport System
FOK RB.....	Radiation Belt model by M-C Fok
FOK RC	Ring Current model by M-C Fok
FOXSI	Focusing Optics X-ray Solar Imager (sounding rocket program)
FPI.....	Fast Plasma Investigation
FRBR.....	Functional Requirements for Bibliographic Data
FTE	Full-Time Equivalent
FTE	Flux Transfer Event
FTS.....	Fourier Transform Spectrometer (on ACE)
FUV.....	Far-UltraViolet
FYS.....	First Year Seminar

GBM	GLAST Burst Monitor
GEC	Geospace Electrodynamics Connections (mission concept)
GEM.....	Geospace Environment Modeling
GEST.....	Goddard Earth Science and Technology
GI	Guest Investigator
GIC	Geomagnetically Induced Current
GLAST	Gamma Ray Large Area Space Telescope (former name of Fermi)
GME.....	Goddard Medium Energy Experiment (on IMP-8)
G/MOWG.....	Geospace Management Operations Working Group
GMU	George Mason University
GOES.....	Geostationary Operational Environmental Satellite
GPS	Global Positioning System
GRIPS	Gamma-Ray Imager/Polarimeter for Solar flares (balloon mission)
GRL.....	Geophysical Research Letters
GRS.....	Gamma Ray Spectrometer (on SMM)
GSFC.....	Goddard Space Flight Center
GSRP.....	Graduate Student Researchers Program
G-TECHS	Goddard Thermal Electron Capped Hemisphere Spectrometer
GUMICS.....	Grand Unified Ionosphere-Magnetosphere Coupling Simulation
GUVI.....	Global Ultraviolet Imager (on TIMED)

HAO.....	High Altitude Observatory (of NCAR)
HDMC.....	Heliophysics Data and Modeling Consortium
HEAO	High-Energy Astrophysical Observatory
HELEX.....	Heliophysical Explorers (NASA-ESA mission)
HELM	Heliophysics Event List Manager (VxO project)
HENA	High Energy Neutral Atom imager (on IMAGE)
HET	High Energy Telescope (of STEREO IMPACT)
HGI.....	Heliophysics Guest Investigator
HGO	Heliophysics Great Observatory
HI.....	Heliospheric Imager (on STEREO)
HMI	Helioseismic and Magnetic Imager (on SDO)
HPEG.....	High-Precision Electric Gate
HSD	Heliophysics Science Division
HST.....	Hubble Space Telescope
HTS.....	High-Temperature Superconductor
HYDRA.....	Not an acronym. Hot Plasma Analyzer (on Polar)
HXRBS.....	Hard X-Ray Burst Spectrometer (on SMM)

IAU.....	International Astronomical Union
IBEX	Interstellar Boundary Explorer
ICESTAR.....	Interhemispheric Conjugacy Effects in Solar Terrestrial and Aeronomy Research
IDL.....	Interactive Data Language (for data and image analysis)
IGY.....	International Geophysical Year
IHY	International Heliophysical Year
IKI	Russian Space Research Institute
ILWS.....	International Living with a Star (heliophysics program)

IMAX	Isotope Matter Antimatter Experiment (Balloon-borne instrument)
IMACS	Imaging Multi-Aperture Coronal electron Spectrograph
IMAGE.....	Imager for Magnetopause-to-Aurora Global Exploration (satellite)
IMF	Interplanetary Magnetic Field
IMP	Interplanetary Monitoring Platform
IMPACT.....	In situ Measurements of Particles and CME Transients (instrument on STEREO)
IMS.....	Ion Mass Spectrometer
INMS	Ion-Neutral Mass Spectrometer
IP	Interplanetary
IPY.....	International Polar Year
IR.....	InfraRed
IRAD	Independent Research and Development
IRI	International Reference Ionosphere
IRIS	Interface Region Imaging Spectrograph (future solar SMEX)
ISAS.....	Japan's Institute for Space and Aeronautical Science
ISCORE	Imaging Spectrograph of Coronal Electrons
ISEE.....	International Sun Earth Explorer
ISIS.....	International Satellites for Ionospheric Studies
ISO	International Standards Organization
ISOMAX	Isotope Magnet Experiment (large balloon payload to measure light isotope ratios)
ISS	International Space Station
ISTP	International Solar Terrestrial Physics
ISWI.....	International Space Weather Initiative
IT	Information Technology
IT.....	Ionosphere-Thermosphere (region)
ITM.....	Ionospheric-Thermospheric-Mesospheric (regions)
ITSP	Ionosphere-Thermosphere Storm Probes
IUE.....	International Ultraviolet Explorer

JAXA.....	Japan Aerospace Exploration Agency
JGR.....	Journal of Geophysical Research
JHU.....	Johns Hopkins University
JPL.....	Jet Propulsion Laboratory (of CIT)
JSC	Johnson Space Center
JSOC	Joint Science and Operations Center

KDP.....	Key Decision Point (in NASA approval process)
KDP-C	KDP for moving project to Phase C
KIMS.....	KeV Ion Magnetic Spectrograph (on RENU)

L1	First Lagrangian point (Sun-Earth gravitational balance point)
LADEE.....	Lunar Atmosphere and Dust Environment Explorer
LADTAG.....	Lunar Airborne Dust Toxicity Advisory Group
LASCO.....	Large Angle and Spectrometric Coronagraph (on SOHO)
LCAS	Low Cost Access to Space (NASA program)
LENA	Low-Energy Neutral Atom (imager on IMAGE)
LEO.....	Low Earth Orbit
LFM.....	Lyon-Fedder-Mobarry (MHD code)

LISM	Local Interstellar Medium
LLBL	Low-Latitude Boundary Layer
LMATC	Lockheed Martin Advanced Technology Center
LMSAL.....	Lockheed Martin Solar & Astrophysics Laboratory
LOC	Local organizing committee
LOS	Line-of-Sight
LPP.....	Laboratoire de Physique des Plasmas (of CNRS)
LPW	Langmuir Probe and Waves (on MAVEN)
LSU	Louisiana State University
LTE.....	Local Thermodynamic Equilibrium
LW	Long Wavelength
LWS	Living With a Star (NASA HSD program)
<hr/>	
MACS.....	Goddard's Multi-Aperture Coronal Spectrograph
MaCWAVE.....	Mountain and Convective Waves Ascending Vertically (program)
MAG	Magnetometer (e.g., on Voyager, ACE, and STEREO)
MagCon.....	Magnetospheric Constellation
MAS	MHD About a Sphere
MAVEN.....	Mars Atmosphere and Volatile Evolution (Mars Scout, to launch in 2013)
MC	Magnetic Cloud
MCAT	Magnetic Cloud Analysis Tool
MDI	Michelson Doppler Imager (on SOHO)
MDR	Mission Definition Review
MEGS.....	Multiple EUV Grating Spectrograph (part of SDO EVE)
MENA.....	Medium-Energy Neutral Atom imager (instrument on IMAGE)
MESSENGER	MERCURY Surface, Space ENVIRONMENT, GEOCHEMISTRY and RANGING
MFI	Magnetic Field Investigation (on Wind)
MGS.....	Mars Global Surveyor
MHD.....	MagnetoHydroDynamic(s)
MINI-ME.....	Miniature Imager for Neutral Ionospheric atoms and Magnetospheric Electrons (on the Space Test Program spacecraft)
MIT	Massachusetts Institute of Technology
MK.....	Mega Kelvin (106 K)
MLSO.....	Mauna Loa Solar Observatory
MLT	Mesosphere and Lower Thermosphere
MLTI.....	Mesosphere and Lower Thermosphere/Ionosphere
MMC	Magnetosphere Mission Concept
MMS	Magnetospheric MultiScale
MO&DA.....	Mission Operations and Data Analysis
MOC.....	Mission Operations Center
MOR	Mission Operations Room
MOSES	Multi-Order Solar EUV Spectrograph (sounding rocket)
MOWG	Management Operations Working Group
MROI.....	Magnetic Range of Influence
MS.....	Master of Science
MSc	Master of Science
MSFC.....	Marshall Space Flight Center

MSTIDS.....	Medium-Scale Traveling Ionospheric DisturbanceS
MSQS.....	Magnetospheric State Query System
<hr/>	
NAC.....	NASA Advisory Council
NAS.....	National Academy of Sciences
NASA.....	National Aeronautics and Space Administration
NCAR.....	National Center for Atmospheric Research (in Boulder, CO)
NEAR.....	Near Earth Asteroid Rendezvous
NESC.....	NASA Engineering and Safety Center
NGAPS.....	NASA Goddard Association of Postdoctoral Scholars
NGDC.....	NOAA Geophysical Data Center
NHK.....	Nippon Hōsō Kyōkai (Japanese Broadcasting Corporation)
NIR.....	Near InfraRed
NOAA.....	National Oceanographic and Atmospheric Administration
NPP.....	NASA Postdoctoral Program
NRAO.....	National Radio Astronomy Observatory
NRC.....	National Research Council
NRL.....	Naval Research Laboratory
NSF.....	National Science Foundation
NSO.....	National Solar Observatory
NSSDC.....	National Space Science Data Center (at GSFC)
NWS.....	[NOAA] National Weather Service
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OMNI.....	Not an acronym; OMNI data are spacecraft interspersed, near-Earth solar-wind data
ONR.....	Office of Naval Research
OpenGGCM.....	Open Geospace General Circulation Model
OPR.....	Outer Planets Research
<hr/>	
PDR.....	Preliminary Design Review
PEACE.....	Plasma Electron and Current Experiment (on Cluster)
PFSS.....	Potential Field Source Surface
PhD.....	Doctor of Philosophy
PI.....	Principal Investigator
PIC.....	Particle-in-Cell (in simulation code)
PICARD.....	Not an acronym; a French solar irradiance, helioseismology, and metrology mission named after astronomer Jean Picard.
PISA.....	Plasma Impedance Spectrum Analyzer (Space Test Program spacecraft)
PLP.....	Planar Langmuir Probe (on C/NOFS)
PMC.....	Polar Mesospheric Clouds
PSU.....	Pennsylvania State University
PWG.....	Polar-Wind-Geotail
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R_E	Radius of the Earth
R_S	Radius of the Sun
R&D.....	Research and Development
RAS.....	Royal Astronomical Society [British]
RAS.....	Russian Academy of Sciences

RAISE..... Rapid Acquisition Imaging Spectrograph Experiment (on sounding rocket)
 RB..... Radiation Belt
 RBE Radiation Belt Environment
 RBSP Radiation Belt Storm Probes
 RC Ring Current
 RENU..... Rocket Experiment for Neutral Upwelling
 RHESSI Ramaty High Energy Solar Spectroscopic Imager
 ROSES..... [NASA] Research Opportunities in Space and Earth Sciences
 RPI Radio Plasma Imager (on IMAGE)
 RPWS..... Radio and Plasma Wave Science (instrument on Cassini)
 RQ..... Radio Quiet

SABER..... Sounding of the Atmosphere using Broadband Emission Radiometry
 (instrument on TIMED)
 SBIR..... Small Business Innovative Research
 SCIFER Sounding of the Cleft Ion Fountain Energization Region
 SCOSTEP Scientific Committee on Solar-Terrestrial Physics
 SDAC Solar Data Analysis Center (at GSFC)
 SDAT..... Science Data Analysis Tool
 SDO Solar Dynamics Observatory
 SECCHI Sun–Earth Connection Coronal and Heliospheric Imager (on STEREO)
 SECEF Sun–Earth Connection Education Forum
 SED Science and Exploration Directorate (at GSFC)
 SED Sun-Earth Day
 SEE..... Solar EUV Experiment (on TIMED)
 SERB Space Experiment Review Boards
 SERTS Solar Extreme-ultraviolet Research Telescope and Spectrograph (rocket)
 SESDA..... Science and Exploration Data Analysis (the prime science and explorations
 data analysis contract at GSFC)
 SESI..... Science and Engineering Student Intern
 SHINE..... Solar, Heliospheric, and Interplanetary Environment (affiliation of researchers
 within the solar, interplanetary, and heliospheric communities)
 SI Stellar Imager
 SIGGRAPH..... Special Interest Group on GRAPHics and interactive techniques
 SIM..... Spectral Irradiance Monitor (on SORCE)
 SIS Science Information Systems
 SIS Solar Isotope Spectrometer (on ACE)
 SMD..... Science Mission Directorate
 SMEX..... Small Explorer
 SMM Solar Maximum Mission
 SOC..... Science Operations Center
 SOC..... Scientific Organizing Committee
 SOHO Solar and Heliospheric Observatory
 SOLSTICE Solar Stellar Irradiance Comparison Measurement (on SORCE)
 SORCE..... Solar Radiation and Climate Experiment (satellite)
 SOT Solar Optical Telescope (on Hinode)
 SPP, SP+ Solar Probe Plus
 SSDO Space Science Data Operations

SPASE	Space Physics Archive Search and Extract
SPD	Solar Physics Division of the AAS
SPDF	Space Physics Data Facility
SPICE.....	Spectral Imaging of the Solar Environment (for Solar Orbiter)
SPSO	Science Proposal Support Office
SR&T.....	Supporting Research & Technology (NASA program)
SSAC	Space Science Advisory Committee
SSC.....	STEREO Science Center
SSCWeb.....	Satellite Situation Center Web (at GSFC's SPDF)
SSDO	Space Science Data Operations
SSMO.....	Space Science Mission Operations
SSN	Sunspot Number
SSREK.....	Solar System Radio Explorer Kiosk
STAFF	Spatial Temporal Analysis of Field Fluctuations (on Cluster)
ST5.....	Space Technology 5
STDT	Science and Technology Definition Team
<hr/>	
TDS.....	Time Domain Sampler (instrument on Wind and STEREO)
TDSS.....	Slow TDS receiver
TECHS.....	Thermal Electron Capped Hemisphere Spectrometer (on SCIFER)
TES.....	Thermal Emission Spectrometer (on MGS)
TGF.....	Terrestrial Gamma-ray Flashes
THEMIS	Time History of Events and Macroscale Interactions during Substorms (fleet of 5 spacecraft)
TIDE	Thermal Ion Dynamics Experiment (on Polar)
TIGER.....	Trans-Iron Galactic Element Recorder (balloon-borne instrument)
TIM.....	Total Irradiance Monitor (on SORCE, and to fly on Glory)
TIMS.....	Technical Information and Management Services
TIMED	Thermosphere Ionosphere Mesosphere Energetics and Dynamics
TOPIST.....	TOPside Ionogram Scaler with True height (algorithm)
TR&T	Targeted Research & Technology (in LWS program)
TRACE.....	Transition Region and Coronal Explorer
TRICE.....	Twin Rockets to Investigate Cusp Electrodynamics
TSC	Technology Steering Committee
TSSM	Titan Saturn System Mission (joint NASA/ESA proposal)
TTI.....	Thermospheric Temperature Imager (on Space Test Program spacecraft)
TWINS.....	Two Wide-angle Imaging Neutral-atom Spectrometers
<hr/>	
UAH.....	University of Alabama Huntsville
UCB	University of California, Berkeley
UCLA.....	University of California, Los Angeles
UK.....	United Kingdom
ULF	Ultra-Low Frequency
UMCP.....	University of Maryland, College Park
UMd.....	University of Maryland
UMBC.....	University of Maryland, Baltimore County
UN	United Nations
UNBSS.....	United Nations Basic Space Science

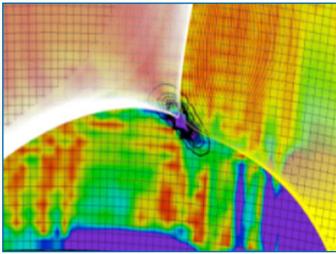
UNH University of New Hampshire
 US..... United States
 USAF..... United States Air Force
 USNA..... United States Naval Academy
 USRA..... Universities Space Research Association
 USU-GAIM Utah State University Global Assimilation of Ionospheric Measurements model
 UTD..... University of Texas at Dallas
 UV UltraViolet
 UVCS UV Coronagraph Spectrometer (on SOHO)
 UVSC [Solar] UV Spectro-Coronagraph

VDF..... Velocity Distribution Function
 VEFI..... Vector Electric Field Instrument (on C/NOFS)
 VEPO Virtual Energetic Particle Observatory
 VERIS..... VERY high angular Resolution Imaging Spectrometer (sounding rocket)
 VGA Venus Gravity Assist
 VHO Virtual Heliospheric Observatory
 VIM..... Voyager Interstellar Mission
 VIRGO Variability of Solar Irradiance and Gravity Oscillations (on SOHO)
 VIS..... Visible Imaging System (on Polar)
 VISIONS..... VISualizing Ion Outflow via Neutral atom imaging during a Substorm
 VITMO Virtual Ionospheric/Thermospheric/Mesospheric Observatory
 VLA [NRAO] Very Large Array (of radio telescopes)
 VLF Very Low Frequency
 VMO/G..... Virtual Magnetic Observatory at Goddard
 VMR..... Volume Mixing Ratio
 VRML Virtual Reality Modeling Language
 VSO Virtual Solar Observatory
 VUV Vacuum UltraViolet (0.1–190 nm)
 VWO..... Virtual Wave Observatory
 VxO Virtual discipline Observatory (“x” stands for particular discipline)

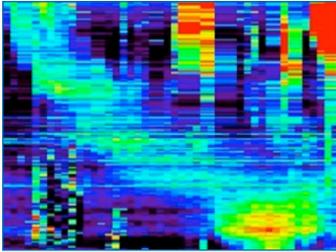
WAVES..... Not an acronym; a radio and plasma-wave instrument (on Wind)
 WDC..... World Data Center
 Wind..... Not an acronym; NASA spacecraft in the Global Geospace Science Program
 WINDMI Wind-Driven Magnetosphere-Ionosphere (model)
 WSA Wang-Sheeley-Arge (model; predicts background solar wind speed and Interplanetary magnetic field polarity at Earth)

XMM..... X-ray Multi-Mirror Mission (ESA mission, now XMM-Newton)
 XRS X-Ray Sensor (on GOES)
 XRT X-Ray Telescope (on Hinode)

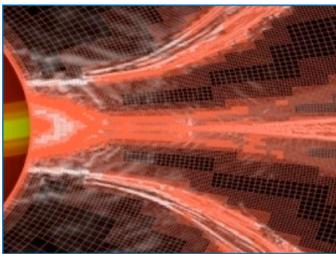
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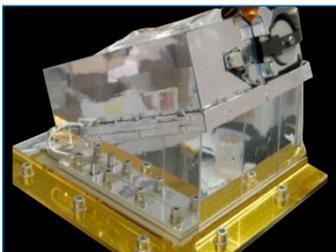
Evolution of an embedded bipole moving from an open-field coronal hole into a closed-field region via interchange reconnection; The global topology after 7480 seconds elapsed time (see page A6).



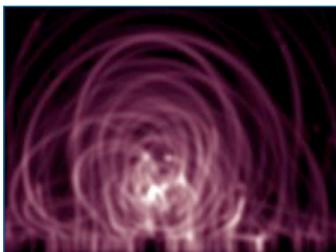
A 6-hour data interval showing the start and stop of the isolated terrestrial myriametric radio burst observed simultaneously by IMAGE and Geotail (see page A35).



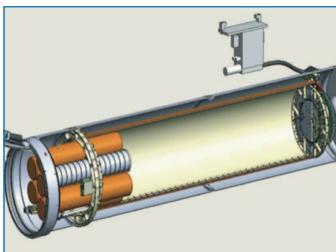
Close-up view of the flare reconnection region at the height of the flare phase during a 2.5D MHD simulation of a breakout CME. Post-eruption loops are visible at left, above the equator, while the back of an erupting flux-rope CME is visible at the right (see page A53).



The Thermospheric Temperature Imager was delivered and integrated with the FASTSat spacecraft in September 2009 and will be launched in November 2010 as part of the Department of Defense Space Test Program (see page A107).

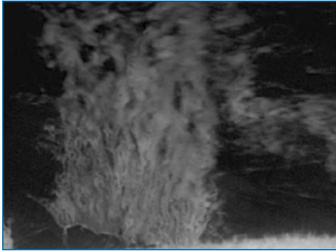


Off-limb synthesized image of the model prominence obtained from thermal nonequilibrium simulations, and temperature response of the AIA/SDO 211A emission line. The LOS is parallel to the prominence filament channel edge (see page A70).

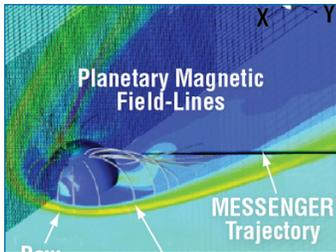


The FOXSI payload with an array of seven telescopes and seven detectors. The payload will be oriented with the detectors located at the front of the rocket. Separation of the rocket engine will allow the optics to be revealed after opening the telescope door (see page A17).

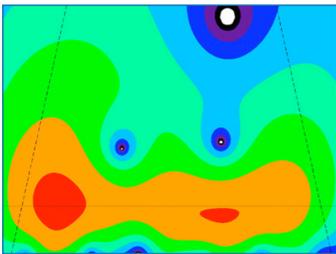
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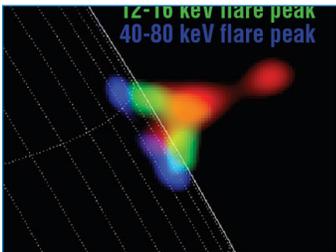
Prominence shows the complicated fine structure and both horizontal and vertical motions. Observing prominence flows and structure in high-resolution data (both ground and space-based) in combination with modeling will advance our physical understanding of how prominences form and how they are supported (see page A36).



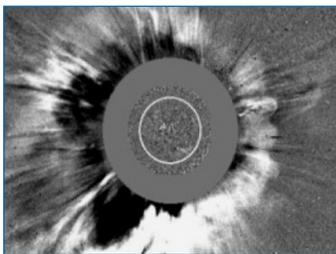
3D MHD simulation of MERcury during Messenger's second flyby. Shown on the right is a direct comparison of the simulated magnetic field, extracted along the MESSENGER trajectory, and actual MESSENGER MAG data (see page A37).



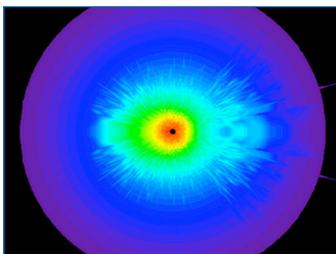
A Paul wavelet spectrum of the F10.7 solar radio irradiance. Shown here is a contour plot of the wavelet power normalized by the variance of the data (see page A89).



Composite RHESSI image at the peak time of a flare in two X-ray energy bands, and of the pre-flare structure in a third X-ray energy band. The flare image shows the thermal flare loop (green) and nonthermal loop footpoints (blue). (see page A45).

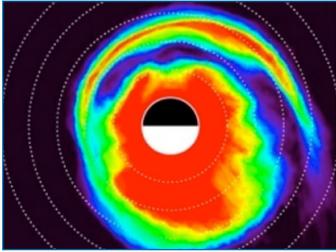


The CME from the source region on 2000 October 9 at 23:50 (right) studied the quantitative link between coronal mass ejection speeds and the amount of magnetic helicity in CME source regions (mostly active regions). (see page A52).

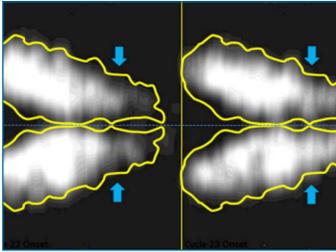


Full Cluster electron VDF in a coordinate system relative to the mean local magnetic field (see page A121).

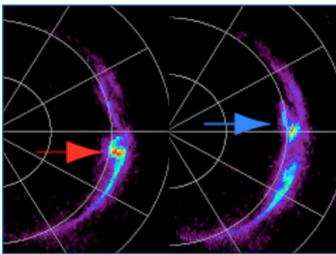
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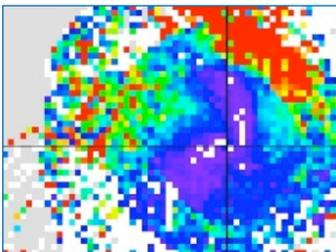
A statistical map of the occurrence and distribution of plasmaspheric He⁺ during the recovery phase of a geomagnetic storm(see page A2).



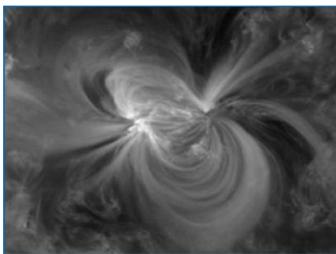
The “Butterfly Diagram” of strong-field ($B > 25$ G) magnetic flux shows low-latitude Cycle 23 flux persisted in the South long after it had faded in the North (see page A99).



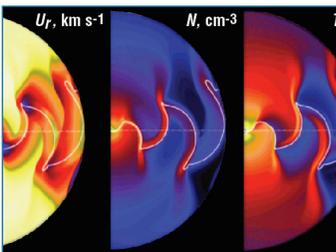
Plasma sheet behavior during auroral substorm expansion (see page A100).



The occurrence rate of $B_z > 0$ nT is shown for the five THEMIS spacecraft when WIND simultaneously measured a time interval with a maximum V_y value larger than 100 km/s (see page A80).

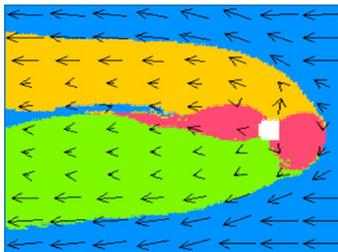


Solar active region observed by SDO showing loops heated by nanoflares (see page A61).

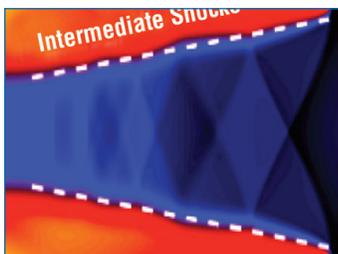


Contour plots of computed solar wind parameters in the meridional plane from 0.3-20 AU for a source dipole field on the Sun tilted by 30 degrees (see page A118).

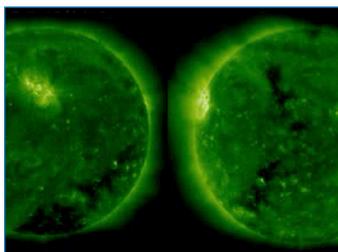
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Magnetic field topology in global magnetosphere simulation: blue = solar wind, yellow = connected to northern hemisphere, green = connected to south, red = closed field lines (see page A94).



Resistive magnetohydrodynamic simulations of relativistic magnetic reconnection – plasma flows and shock structures around the plasmoid in the very late stage (see page A133).



Coordinated EUV coronal movie of an active region eruption observed simultaneously from STEREO B and SDO that can be used to derive the 3D structure of the optically thin coronal plasma (see pages C3 and C8).

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14. ABSTRACT This report is intended to record and communicate to our colleagues, stakeholders, and the public at large about heliophysics scientific and flight program achievements and milestones for 2010, for which NASA Goddard Space Flight Center's Heliophysics Science Division (HSD) made important contributions. HSD comprises approximately 323 scientists, technologists, and administrative personnel dedicated to the goal of advancing our knowledge and understanding of the Sun and the wide variety of domains that its variability influences. Our activities include: Leading science investigations involving flight hardware, theory, and data analysis and modeling that will answer the strategic questions posed in the Heliophysics Roadmap; Leading the development of new solar and space physics mission concepts and support their implementation as Project Scientists; Providing access to measurements from the Heliophysics Great Observatory through our Science Information Systems; and Communicating science results to the public and inspiring the next generation of scientists and explorers.					
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